



# THE INDIAN JOURNAL OF SURGERY

VI

SEPTEMBER & DECEMBER 1944

Nos. 3 & 4

अभिजगन्त्रं निष्कान्तं प्रवेदयं नान्यथा भवेत् ।  
 विषोलिकाशितोऽस्तं तदप्यंके वदन्ति तु ॥ ५६ ॥  
 प्रक्षाल्य पयसा दिग्धं तृणशोणितपांशुभिः ।  
 प्रवेशयेत् कृत्तनखो घृतेनाक्तं शनैःशनैः ॥ ५७ ॥  
 प्रवेशयेत् क्षीरसिक्तं शुष्कमन्त्रं घृताप्लुतम् ।  
 अक्षुल्ल्याभिमृशेत् कण्ठं जालेनोद्वेजयेदपि ॥ ५८ ॥  
 तथान्त्राणि विशन्त्यन्तः स्वां कलां पीडयन्ति च ।  
 त्रणास्त्रान्वाह्रुत्वाद्वा दुष्प्रवेशं भवेत्तु यत् ॥ ५९ ॥  
 तदापाट्य प्रमाणेन भिषगन्त्रं प्रवेशयेत् ।  
 यथास्त्रनं निक्षिपे च त्रणं सीव्येदतन्द्रितः ॥ ६० ॥  
 स्थानादपेतमादत्ते प्राणान् सुम्पितमेव वा ।  
 वेष्टयित्वा तु पट्टेन घृतसेकं प्रदापयेत् ॥ ६१ ॥

## SUSHRUTA SAMHITA—CHIKITSA STHANA Chapter, II

*Sushruta devotes a special chapter to the treatment of injuries caused by accidents. The above is the procedure adopted when the peritoneal wall is punctured as a result of accident or sword-thrust, and a part of the intestines escapes through the opening—*

*The intestines, that have come out, should be pushed in, if uninjured, not otherwise. According to some other acharyas, the injury can be repaired, by bringing the cut edges together and making ants bite over the part, and the intestines then replaced. The surgeon, whose duty it should be closely trimmed, first washes the prolapsed portion of the intestines, with water to remove any bits of grass, dust or blood, anoints it over with ghee, and pushes gently in. If the bowels have become dry and shrunk, they should be washed with milk and plenty of ghee applied. Vomiting may be induced by tickling the throat with the*



*finger or a feather, so that the intestines may be sucked in by the muscular action and made to resume their normal position. But if the wound in the abdominal wall is too small, or the portion of the intestines that has escaped too big, to allow of its easy replacement, the opening is enlarged to the required size and the contents put back. The wound is sutured after making sure that the intestines are in their normal position, because, it might endanger the life of the patient, if they are not in their natural places, or are huddled together. The abdomen is bandaged and ghee poured over the part.*

*The condition was naturally considered very serious, but not hopeless, as is evinced by these lines—*

स्वमार्गप्रतिपन्नास्तु यस्य विण्मूत्रमारुताः ।

व्युपद्रवः स भिन्नेऽपि कोष्ठे जीवति मानवः ॥

*The man who passes faeces, urine and wind, through the normal passages and who is free from distress, lives even if his abdomen is cut open.*

# INTRAPELVIC PROTRUSION OF THE ACETABULUM

BY

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## Introduction

Intrapelvic protrusion of the acetabulum first described as long ago as 1824, by Otto as "an abnormal gouty manifestation," has not received, particularly in text books of surgery or radiology, the attention it deserves. It is true that the condition is not frequent and up to 1939 only 120 cases has been described in the literature, mostly from the European Continent and a few from the United States of America. In reviewing all the X-rays of the hip joint of a large hospital, it was found that the condition was certainly more frequent than 120 reported cases in 120 years suggest, and it was felt that the attention of the surgeons of this country should be drawn to this condition. In a search of the literature, no case seems to have been reported amongst Indian subjects, and one felt from the survey of the X-ray records of the last five years of the Sri Krishnarajendra Hospital, Mysore, that a few observations on the condition would not be out of place.

## Definition

The condition of intrapelvic protrusion of the acetabulum may be defined as a non-traumatic progressive protrusion of the acetabulum and the head of the femur into the pelvis.

## Historical

First described in Germany by Otto in 1824 as "an abnormal gouty manifestation," the condition has been referred to under various names by different authors. Eppinger (1903) referred to it as "Coxarthrolisthesis-Becken," Kuliga (1905) as "osteoarthritis deformans," Schlangenhauer (1908) as "Gonorrheal arthritis," Chiari (1912) as "tabetic Coxarthrosis." Doub (1929) as "intrapelvic protrusion of the acetabulum." It is generally described as "Otto pelvis," though some, like Eppinger have called it "Chrobak pelvis."

Otto's original description was that of a female pelvis in an anatomical museum. The description reads—"This pelvis, from an adult woman, is, on the whole, fairly normal in size and build, its chief characteristic is the very deep insertion of both femoral heads in the acetabula, so that the floors of the latter protrude far into the pelvis, and are at the same time imperfectly ankylosed. The right acetabulum protrudes into the pelvis like half

an orange. The left hip behaves much like the right. The right sacro-iliac symphysis is ankylosed for about an inch."

### Incidence

From the literature it is found that of 79 cases of intrapelvic protrusion of the acetabulum, only 41 cases seem to be true Otto pelvis. This seems rather strange in view of the fact that Gilmour in 1939 reported twelve cases, eight of them personal cases, and one feels that the condition is not so rare as the published statistics would lead us to believe. In a review of 500 radiographs of pathological conditions of the hip taken over a period of five years, in the Sri Krishnarajendra Hospital, Mysore, six cases of typical intrapelvic protrusion were collected. This brings the incidence of the condition to a little over 1% of all pathological hips, a no inconsiderable figure, and it was felt that a detailed description of the condition was justified.

From the literature it is found that the condition is definitely more common in women than in men in the proportion of two to one. It is most common in middle life, the oldest recorded case being in a man of 70 years, and the youngest in a girl of ten years. In 49 of the 79 reported cases, the disease was unilateral and in the other thirty it was bilateral.

In the following six cases there were 3 women and 3 men, and in all of them except one, the disease was unilateral.

### Symptoms and Physical findings

In an average case, the chief complaint is a painful hip joint of slight severity lasting for months or years prior to presenting before the doctor. A limp gradually develops, gait becomes wobbling, and the person finds it difficult to stoop or bend. There is great uneasiness, pain and difficulty in squatting, and, in advanced cases, the patient may hardly be able to walk.

On physical examination there is marked limitation of abduction and external rotation. The greater trochanter may sometimes be felt to grate on the ala of the ileum. Fixed flexion deformity with pelvic rotation and lordosis may be present. Due to the projection of the femur into the pelvis, real shortening occurs. Occasionally the acetabulum and the head of the femur may be felt above the inguinal ligament, and sometimes very readily demonstrated by a rectal or vaginal examination.

### Roentgenography

The diagnosis of intrapelvic protrusion can only be confirmed, and depends in the end, on radiological evidence. Before describing the appearances of a case of protrusion, the X-ray appearances of a normal hip joint needs to be described.

Köhler has described accurately the various characteristic lines in the neighbourhood of the acetabulum. From the radiogram and the key diagram,



Fig. 1. Normal hip joint

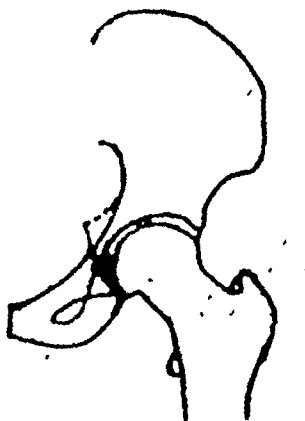


Fig. 1a. Line drawing of normal hip showing 'drop tear' figure.

the various lines are made out. The roof of the acetabulum in adults is normally prolonged outwards some 2—5 mm. in length.

"The acetabular cavity is normally projected as a somewhat flattened semi-circle, interrupted in the middle by a depression with a somewhat shorter radius, caused by the deepening of the fossa acetabuli. In addition there are in the depth of the acetabular cavity two other lines, a small curved line, and a very long almost straight line. The three lines form elements of a single complete picture in dorsal photographs of the hip.

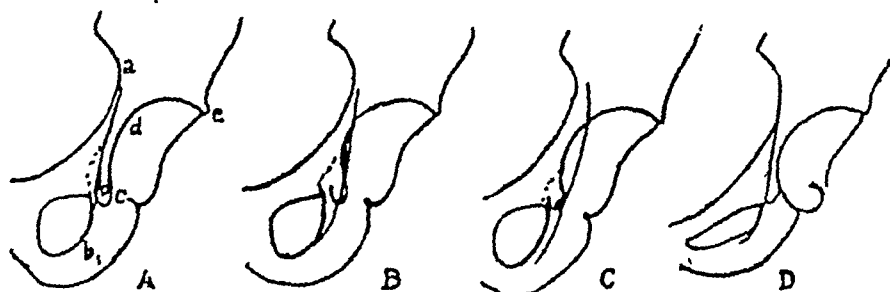


Fig. 2. 'Drop tear' figure in various projections. (From Köhler's "Roentgenology.")

The resulting figure bears a distant resemblance to a tear, and has therefore been called "tear figure." The lines mentioned change their positions in altered positions of the tube, and partially intersect. In the "tear figure" the arch c d e is the one easiest made out. It is the contour of the acetabular cavity (It corresponds exactly in every case to the section of the acetabular wall, that would be cut by an imaginary plane at right angles to the tangential rays). The small semi-circular arch b c corresponds to the part of the bone, where the anterior opening of the acetabular fossa curves

round backwards to the wall of the true pelvis, that is, the half cylindrical corticales at and over the posterior obturator tubercle. The third line  $a b b_1$  is the shadow of the wall of the pelvis running in the direction of the rays."

These three lines do not correspond to borders in the pelvis nor to denser lines in the spongiosa, but to the three more or less curved surfaces. If one looks through different roentgenograms of the hip of different persons or of the same person in different projections, one finds the three lines regularly, but their relative positions are very different: for in nearly all the cases, the line  $b c d e$  remains unbroken, while  $a b b_1$  moves nearer to  $c d e$  and can intersect it completely so that the line  $b c d$  comes to be altogether medial to  $a b b_1$ .

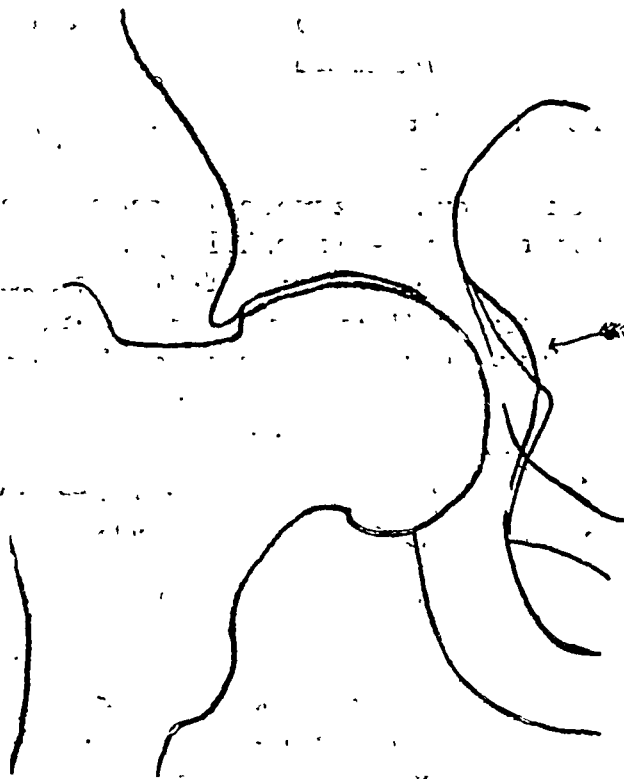


Fig. 3. Line drawing of a case of protrusion. (From Koehler's "Roentgenology.")

In each case of protrusion the "tear figure" naturally undergoes corresponding changes. At first the arch of the acetabulum ( $e d c$ ) is changed; in roentgenograms of the whole pelvis it crosses the line  $a b$  of the true pelvis towards the inner side.

The femoral head fits the acetabular cup closely. The joint space is narrowed, but regular. There is no "tear figure," but the curve of Shenton's arc is preserved.

The fundamental changes occur in the acetabulum. The changes in the acetabulum are possible only as long as the head of the femur is more or less

intact, as it should preserve its boring qualities. The degree of protrusion varies from a few millimeters to four or five centimeters in severe cases. As the acetabulum deepens, it is directed upwards, medially and forwards, so that in extreme cases, apart from narrowing the pelvic outlet, the protrusion may be palpated above the inguinal ligament. In advanced cases, the protrusion into the pelvis may cause a narrowing of the pelvic outlet, and may cause obstruction to labour in women. The inner wall of the protruding acetabulum may be thin and shell-like, or layers of new bone may be deposited on the inside producing a dense wall.

As the projection of the femoral head deepens, a low grade osteoplastic process develops, and ultimately osteo-arthritic changes develop in the acetabulum, most marked at its free edge. In a very advanced case, the osteophytes from the head and from the margins of the acetabulum effectually lock the head of the femur in the acetabulum.

The progress of the femoral head into the acetabulum is stopped when the greater trochanter impinges against the pelvis near the shelf of the acetabulum and the lesser trochanter against the ischium. Further progress inwards of the head of the femur is now impossible, and the inner wall of the acetabulum becomes dense and completely ossified. The active stage of the disease ceases, and further changes at the hip are due to the resultant or associated osteoarthritis at the joint. The deformity thus becomes permanent.

### Etiology

There is wide divergence of opinion regarding this disease. From the literature one gets the impression that the overwhelming majority believe that Otto pelvis is not a disease entity, but the end-result of an inflammatory process.

Two broad schools of thought may be classified. Those that believe in the inflammatory theory, and those that believe that it is a developmental anomaly. Chief among the latter school is Eppinger who postulates a growth disturbance of the Y—cartilage of the acetabulum. He called it a chondrodystrophy and regarded it as the primary cause in the production of Otto pelvis. According to him the Y—cartilage persists, and the acetabulum does not fuse, but is projected into the pelvic cavity.

The majority of people have not upheld the view of Eppinger's chondrodystrophy of the acetabular Y—cartilage, but have inclined to the inflammatory cause of the protrusion. While there seems to be a fair degree of unity of opinion about its inflammatory origin, there is wide divergence as to the causative organism.

Numerous bacterial agents have been held responsible, including tubercle bacillus, gonococcus, streptococcus, etc.; conditions like tabes, gout,

trauma are among the factors believed to be important from the etiological standpoint.

The tuberculous basis of the process has been stressed by Valentin and Mueller. In a large number of cases no such relationship can be made out and the termination of a typical Otto pelvis is very unlike that of tuberculous arthritis.

Several authors have stressed the gonorrheal origin of the condition. In a case of Schlangenhauer in 1909, the gonococcus was found in the hip joint at autopsy. This is the only recorded case where the gonococcus has been demonstrated bacteriologically inside the joint.

Metastatic malignancy as a causative agent in the production of this deformity has been mentioned by several authors. Chiari reported a case who died of carcinoma of the biliary tract. Henschen has collected from the literature seven cases due to Echinococcus infection.

The role of trauma in the causation of Otto Pelvis has caused a great deal of controversy. In some of the cases the trauma has been sustained over 16 years before the onset of symptoms or the recognition of the condition. In a few a combination of trauma and gonococcus has been attributed as the cause.

From the large number and variety of etiological factors attributed to the formation of Otto pelvis, it is obvious that we are far from understanding the cause or the exact underlying pathological processes.

Gilmour in a careful analysis of his cases, came to the conclusion that a pre-protrusion stage exists which he termed as 'deep acetabulum' or 'acetabula profunda,' and in which, later on, protrusion occurs. His view is that the protrusion occurs during the premenstrual period and at a time of greatest growth. The sequence of epiphyseal growth and epiphyseal fusion is disturbed at a time when rapid growth in length of bones and muscular development is taking place, and consequent delay in the fusion of the Y-shaped cartilage. He has demonstrated that where there is unilateral protrusion there is a deep acetabulum on the opposite side, and so the cause of protrusion should be looked for elsewhere than locally in the hip or acetabulum. In support of this view, measurements of the pelves of his series show a relative increase in the intercrystal diameter over the intertrochanteric diameter, and an intertuberosus diameter always less than the normal. In his opinion intrapelvic protrusion is only a part of a general growth disturbance of the whole pelvis.

### Case Reports

Case 1.—S.—female. 29 years of age of moderate build. Married. 2 children, both normal labour. In 1934 had fever, with painful nodular swellings in the right groin, for

two days. The fever subsided, but the right hip joint was painful and walking difficult. She was in a plaster of paris cast for 4 months, and was able to walk with some difficulty after its removal. She had a normal labour in 1936, and in 1938 she had a recurrence of pain in the right hip which was relieved by rest. Towards the end of 1940 she had another normal labour.

The present attack started gradually in January 1943 and she noticed that walking was getting more difficult. She sought admission in February 1944 as the pain and difficulty was increasing.

On examination, the right limb is slightly everted, and she walks with a limp on the side. The movements at the hip are markedly limited in all directions, and painful. The muscles of the thigh are wasted, and there is a real shortening of 1.5 cms. No abnormality of the spine.

Blood—urea, phosphorous and calcium normal. Urinalysis—nothing abnormal; culture—sterile. W.R.—ve. No evidence of gonorrhoeal infection.

#### Röntgenography—

The left hip joint is normal. The right hip joint space is narrowed. The acetabulum projects into the cavity of the pelvis to a depth of 1 cm. There are osteophytic

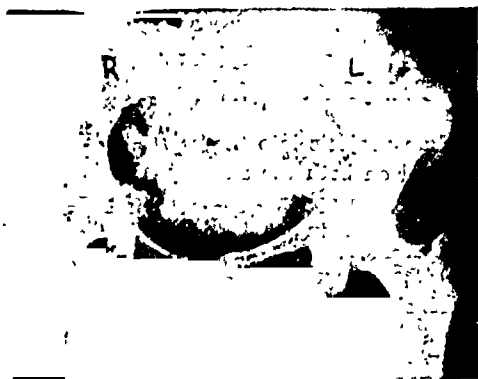


Fig. 4. Case 1.



Fig. 4a. Line drawing of right hip.

growths from the margins of the acetabulum. Kœhler's 'tear drop' figure is absent on the right side, and well formed on the left. The bone texture is normal on both the sides.

Diagnosis—Intrapelvic protrusion of the right acetabulum with osteo-arthritis of the right hip joint.

Case 2.—K. G.—male. 26 years of age. In July of 1940 he noticed slight pain in the left hip on walking and limped about for 3 days. The pain increased, and he took to bed and developed fever which lasted for 8 days. The fever subsided and the pain gradually lessened, but there was difficulty in using the left lower limb. He got massaged without any relief. He was admitted to the Krishnarajendra Hospital in September of 1940 on account of pain in the left hip.



On examination, the left lower limb is flexed and slightly everted. The muscles of the left thigh and gluteal region are wasted, with tilting of the pelvis. All the movements at the hip are impaired and painful. There is apparent lengthening of 2 cms., but there is no real shortening. The spine is normal.

Urinalysis—nothing abnormal. W.R.—negative.

*Roentgenography—*

Radiogram of the pelvis and hip taken on 6-9-1940. The joint space of the left hip is diminished and the acetabular margins are fuzzy. The head is well delineated. The



Fig. 5. Case 2 on 6-9-1940.

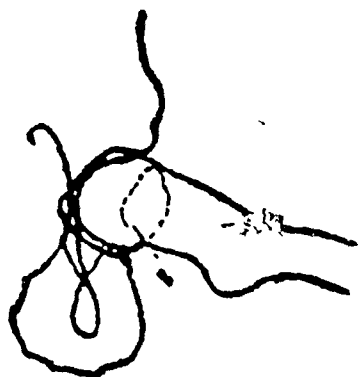


Fig. 5a. Line drawing of left hip.

"tear drop figure" is distorted and the acetabulum projects into the pelvis to the extent of about 4-5 mm. Shenton's line is well preserved on both the sides. There is no evidence of osteoarthritis or decalcification. The right hip appears practically normal, and there is slight crowding of the lines of Koehler, suggesting a tendency towards deep acetabulum.

Diagnosis—Intrapelvic protrusion on the left side with deep acetabulum on the right side.



Fig. 6. Case 2 on 18-1-1944.

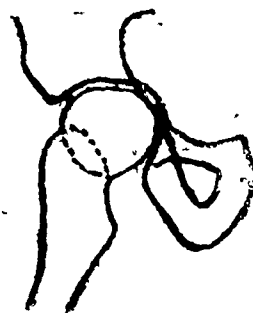


Fig. 6a. Line drawing of left hip.

Another radiogram was taken of the same patient on 18-1-1944, during which time the patient was at home undergoing no treatment, but limping about with the aid of a stick. This radiogram shows slight decalcification on the left side, but the deformity, the narrow joint space, and the fuzziness of the acetabulum remain. Osteo-arthritic changes are present at the rim of the acetabulum, but it is interesting to note that the amount of protrusion of the acetabulum into the pelvic cavity remains the same. The right hip joint does not show any variation from the previous radiogram.

Case 3.—K.—female. 25 years of age. Of short stocky build. Married. In 1932 had a fall from a height of 4 feet and was unconscious for a few minutes and completely recovered. In 1935 was an inpatient in a hospital for "pain in the region of the hip" when she was given rest for a month which completely relieved her. In 1939 was delivered of a still born child.

In 1940 she had fever with pain all over the body. In three days' time the fever subsided and the pain localised itself in the left hip and the pain is persisting. She has difficulty in walking and squatting. Her general condition is good.

Urine—showed pus cells but was sterile on culture. W.R.—negative.

The movements at the hip joint are limited in all directions, and abduction markedly so.

#### Roentgenography—

Radiogram of pelvis and hip joints taken on 18-5-1940. The left hip joint space is practically lost with the contour of the head of the femur intact. The bones show a slight



Fig. 7. Case 3.



Fig. 7a. Line drawing of left hip.

degree of decalcification. The acetabulum protrudes into the pelvis to the extent of 3 mm. The "tear drop figure" is distorted. There are osteophytic growths from the tip of the acetabulum. The right hip appears normal and Shenton's arc is preserved on both the sides. There is no evidence of any arthritic change in the right hip.

Case 4.—K. N.—male. 38 years. Complains of pain in the lumbar region shooting to the back of the thighs of 2½ months' duration. History of transient swelling of the knee joints while young. Had bacillary dysentery in 1942. He is now unable to walk without support, the pain being more marked on the right side than on the left side.

W.R. of blood and C.S.F.—negative repeatedly.

*Roentgenography—*

Radiogram shows a marked increase in the depth of both acetabula, more marked on the right than on the left. There is an intrapelvic protrusion of the right acetabulum



Fig. 8. Case 4.



Fig. 8a. Line drawing of right hip.

to a depth of 3 mm. The joint space and the bone texture of both the joints appear normal. Early osteo-arthritic changes are in evidence in the right acetabular margins.

*Case 5—L—female 15 years Unmarried.* Three months before admission to the hospital, while travelling in a country cart another person was hurled against her and she got pain in her hips. In a few days she had pain in all the joints of both lower and upper extremities. She had a low grade fever when the pain in the joints would flare up.

The patient is of moderate build. The movement at the hips are slightly painful, but not limited. No other abnormality either in the hips or in other joints could be detected.

Heart sounds are accentuated and extra systoles are present.

Urinalysis showed no abnormality.



Fig. 9. Case 5.

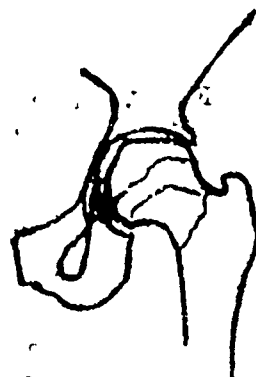


Fig. 9a. Line drawing of left hip.

### Roentgenography—

Both acetabula are wider than normal. The "drop tear figure" is distorted and there is a mild degree of intrapelvic protrusion of both acetabula. The supra femoral lip of the acetabulum is beak shaped, enhancing the depth of the acetabulum. The joint space cannot be made out definitely. The head of the femur is deformed, flattened with fuzzy margins. There is slipping of the head in relation to the neck (slipped epiphysis?). The trabeculae of the head and neck are very delicate, and there is general atrophy and decalcification of the bones.

Diagnosis—Bilateral intrapelvic protrusion with slipped epiphysis and probable epiphysitis of toxic origin.

Case 6—L—female. No history of the case available.

### Roentgenography—

Shows absence of the "tear drop figure" on the left side, and a fairly well pre-



Fig. 10. Case 6.

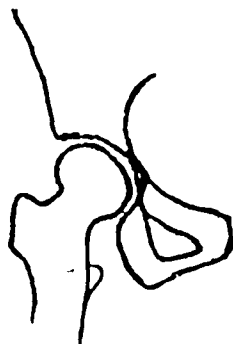


Fig. 10a. Line drawing of right hip

served, though slightly distorted figure on the right side. The left joint space is diminished, and the bones appear normal.

Diagnosis—Unilateral deep acetabulum

### Comment—

From the above six cases reported, there is an equal distribution amongst both the sexes. In all our cases definite diagnosis was possible only after roentgenological examination, though in Case 1, it was suspected on account of the insidious onset of the disease and the good general condition of the patient.

In all the cases except Case 6, where no history was available, there is a history of fever in direct relationship with the joint disability. This suggests that the cause for intrapelvic protrusion may be inflammatory, either bacterial or toxic.

Gilmour's view that the condition is practically always bilateral does not accord with our observations. Except in Case 5, where there are manifest changes in the head and neck of the femur unlike the other cases, the condition is unilateral. In the female patients, the pelvimetric measurements are within normal limits and do not show any reversal in the intercrystal and intertrochanteric diameters, nor a diminution in the intertuberous diameter.

Trauma as a definite etiological factor cannot be substantiated. Except in cases 3 and 5 there is no definite history of trauma. In no case could a history of gonorrhoea be obtained, nor could the gonococcus be demonstrated in the urogenital tract. It is possible that these arthritides are due to absorption of toxins from some septic focus, and the localisation of the lesion is probably brought about by trauma, in some cases the trauma being too insignificant to be remembered or to be associated with this condition.

Radiograms taken after an interval of 3—4 years as in case 2 show that there is no progress in the protrusion, though the trochanter has not come into contact with the ileum. This finding is not in accordance with the view held by others.

### Treatment

A rational treatment obviously is not possible as the etiology and pathology is still obscure. Smith-Petersen has performed, successfully, "acetabuloplasty," and prevented further protrusion of the acetabulum and head of the femur. In most cases, however, it appears as if the associated osteoarthritis is the disabling cause and not the protrusion per se.

The treatment would then be for osteo-arthritis of the hip.

### Summary

(1) The condition of intrapelvic protrusion of the acetabulum is described with its radiological features.

(2) Six cases have been reported.

(3) It is observed that this condition is more probably inflammatory in origin than a developmental anomaly.

### Acknowledgements

My thanks are due to Dr. C. Krishnaswami Rau, Medical Officer, Sri Krishnarajendra Hospital, and Principal, University Medical College, Mysore, for kind permission to publish this paper and to Dr. A. C. Devaraj, Radiologist, Krishnarajendra Hospital, for the roentgenograms.

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# CANCER OF THE ESOPHAGUS

(A review of 153 cases)

BY

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Among the malignant diseases perhaps the deadliest is cancer of the esophagus. The very protected and deep situation of the organ is an impediment to the application of surgical and radiological methods which have proved successful in the treatment of cancer in other situations. Radiation can at best produce palliative results and surgery is attended with a high mortality. Since the inception of this hospital we have been faced with this problem so frequently that it may be instructive to review the methods of study and treatment we have used. From March 1941 to December 1942 there have been 153 patients with this disease. This paper is a review based on a study of these cases.

## Incidence

In this same period we have had 5,000 admissions to the clinic. Of these 3,200 suffered from malignant disease. This gives 4.8% as the percentage of cancer of the esophagus. This figure does not by any means represent the true incidence in relation to other malignant diseases in this country, because at this hospital we must expect to see a higher proportion of cancers whose treatment is mainly radiological, as those amenable to surgery only trickle in after selective filtration through the surgical departments of general hospitals. At the Memorial Hospital, New York, the incidence is 2.5% of all malignant disease (Pack & LeFevre). In London Soutter<sup>1</sup> reports an incidence of 5% of all cancers. These figures and the fact that we here have seen 153 cases in 20 months show that cancer of the esophagus is not as uncommon as one is apt to think.

TABLE I. AGE INCIDENCE

30 to 39 years	19 Cases	70 and over	2 Cases
40 to 49 "	47 "	Youngest patients	2 Cases of 31 years
50 to 59 "	61 "	Oldest patient	74 years.
60 to 69 "	24 "		

Table I shows the age distribution of the disease. The maximum figures appear in the 5th and 6th decades. Though this is predominantly a disease of later life it must be noted that two of our patients were only 31 years old; both were treated elsewhere for spasm because of their youth.

As regards the sex of the patient, some unknown factor which also seems to operate in all cancers of the mouth and throat, makes the male more prone to this disease. Among our cases there were 124 men and 29 women, the lesion being about four times more common in males.

TABLE II. COMMUNITY INCIDENCE

HINDOOS:	104
Gujarathis	53
Deccanis	39
Others	12
MUSLIMS:	32
Bombay	12
Gujarath	4
Khoja & Bori	5
Others	11
CHRISTIANS:	13
PARSIS:	3
EUROPEAN:	1

Table II shows the incidence in the various communities that visit this clinic. One immediately notices the high figures among the Gujarathis, 53 out of 153, constituting one-third of the whole series. This predominance is not due to a larger attendance of Gujarathis at this hospital as the relative attendance of Gujarathi and Deccani Hindoos is about the same. We have also noticed this pre-disposition of the Gujarathi community to oro-pharyngeal cancer in our other statistical studies, and investigations are in progress to determine what factors if any are responsible for this curious distribution.

A study of the local etiological factors is not very helpful. The percentage of patients with positive Kahn tests was 10%, which is just a little higher than 6 per cent, the percentage of positive reports we obtained among our unselected blood donors in the course of the last year. Syphilis is therefore not an important factor. Dental sepsis is frequent in these patients, but a few had excellent teeth or had them removed years before. Vegetarians and non-vegetarians are equally affected. From all this it appears that extraneous local factors are perhaps not so important in the etiology, though most observers are inclined to believe that repeated irritation of the gullet by hot or pungent food, or by coarse and unchewed food, has something to do with it.

### Clinical Features

The first and main symptom in almost all the cases is some difficulty in swallowing. At the onset it may be a trivial discomfort which may not worry the patient at all until in a few months the dysphagia is severe enough to make him seek medical advice.



TABLE III. SYMPTOMS AND THEIR DURATION

## FIRST SYMPTOM:

Dysphagia	...	141
Pain	...	8
Pain & dysphagia	...	2
Hoarse voice	...	1
Debility	...	1

## DURATION:

Under 3 months	...	55
3 to 6 "	...	30
6 to 12 "	...	37
Over 1 year	...	11

Minimum duration 2 weeks

Maximum " 4 years

Table III shows that dysphagia is the most common first indication of the disease. Only a few cases had pain and only one had hoarseness as the primary complaint. This disease, though usually so simple to diagnose, occasionally deceives even the most competent physicians and therefore a mention of a few of the mistakes that have come our way will not be out of place. Both the young men of 31 were treated for esophageal spasm before being referred to us because cancer at that age was ruled out. Age should therefore not be considered at all. Carcinoma has so often masqueraded under the guise of cardiospasm and the Plummer-Vinson syndrome that we would urge endoscopic examination in all these cases. Eight such patients have come to us. Then again, apart from the one case included in this series, we have recently come across two others whose first symptom was a hoarse voice. In both these patients the diagnosis was missed by competent laryngologists because they did not complain of dysphagia until some months later. We have made it a rule in a patient who complains of throat symptoms to have a fluoroscopic examination of the oesophagus if nothing to account for the symptoms is seen in the throat. We have been rewarded in two cases by the discovery of an unsuspected lesion of the esophagus.

In over two-thirds of the cases as seen in Table III the symptoms were present for more than 3 months before the patients came for treatment. The great majority of patients come to us so late that we should like every medical practitioner to realise that the early symptoms are absent or trivial, so that a patient with any symptoms referable to the act of deglutition, who is over the age of 30, should be sent to a clinic where adequate X-ray and esophagoscopy facilities are available. Only thus could patients be caught early.

Every patient sent to us with symptoms referred to the act of deglutition is subjected to, besides the usual routine, three methods of examination: A careful mirror scrutiny of the pharynx and larynx, fluoroscopy of the chest

before and after a Barium swallow, and esophagoscopy. The latter two are omitted if definite disease responsible for the symptoms is found in the throat. It is particularly important to exclude aneurysm and other extra-esophageal conditions before attempting endoscopy, and a skiagram after a Barium swallow is of help in indicating the site where a tumour is to be expected. By using a thick emulsion and taking pictures in more than one position it is possible to get an accurate idea of the extent and nature of the lesion. But it must be understood that esophagoscopy is the only method that will detect the very earliest lesion, and also differentiate the malignant from other strictures.

We do all esophagoscopic examinations with local anaesthesia. Pre-medication with morphine gr. 1/6 and atropine gr. 1/150 is given one hour before. A spray of Percaine 1 per cent into the throat and wiping the lower reaches of the pharynx with a swab of Percaine held with a curved forceps is sufficient in most cases. In a nervous individual or an in-cooperative patient it has been occasionally necessary to use general anaesthesia.

In the 153 cases under review esophagoscopy was done in 99. In the rest either the patient did not return for the examination or refused it. A biopsy was taken in every case in which a tumour or ulcer was seen. A positive biopsy was obtained in 83 cases. A definite case of cancer may sometimes yield a repeatedly negative biopsy. In the scirrhus type of lesion where the tumour infiltrates deeply, the mucous membrane above the growth is often edematous and puckered, obstructing the passage of the instrument right up to the tumour; a biopsy at the strictured site therefore occasionally yields innocent tissue. Therefore when X-ray evidence has been conclusive about the diagnosis and no purely inflammatory lesion is suspected, one treats the case as cancer.

The findings on esophagoscopy vary with the nature of the tumour. In the scirrhus type of growth all that is usually seen is a narrowing of the lumen with thickened, puckered mucous membrane around. The polypoid type of cancer tends to spread in the submucosa and is seen as an elevation obscuring the lumen covered frequently by normal looking mucosa. In the ulcerative lesion what meets the eye is a raw bleeding surface with a raised edge often covered with slough or decomposing food particles. In some early lesions the only evidence of disease may be a stiffening of the wall of the tube which affects its normal respiratory excursions. In one patient (case No. 3314) fluoroscopic studies with Barium for symptoms of mild dysphagia revealed no constriction or irregularity of any kind. On esophagoscopy it was found that a segment of the anterior wall of the tube 22 cms. from the incisor teeth did not move well with the respirations though there was no narrowing and the instrument could pass easily. A slightly roughened area on this anterior wall was biopsied to reveal an epidermoid carcinoma grade 2,

This patient was diagnosed early and treated with radium and is alive and well to-day over one year from the date of treatment. This case illustrates the value of endoscopy in early cases as radiological examination had missed the tumour and the patient might have been assured that she had no cancer and valuable time might have been lost before the diagnosis was later made clear. Whenever a lesion is visualised it is wise to biopsy it. This not only confirms the diagnosis, but yields information about the histology of the tumour that is of great help in planning out the best treatment. Also occasionally, one does come across a purely inflammatory stricture as occurred in case No. 2513, a patient who had bilateral pulmonary tuberculosis and an esophageal stricture which repeatedly yielded chronic inflammatory tissue on biopsy; it is more than probable that this patient had a tuberculous stricture.

Clinically, we visualise three types of lesions as identified by their X-ray and endoscopic appearances: (A) Scirrhus, (B) Polypoid and (C) Ulcerative. We like to separate them into these types as we try to be guided in the line of treatment by the type of case we are dealing with.

An X-ray study of these lesions reveals several interesting features about the disease which are tabulated below:—

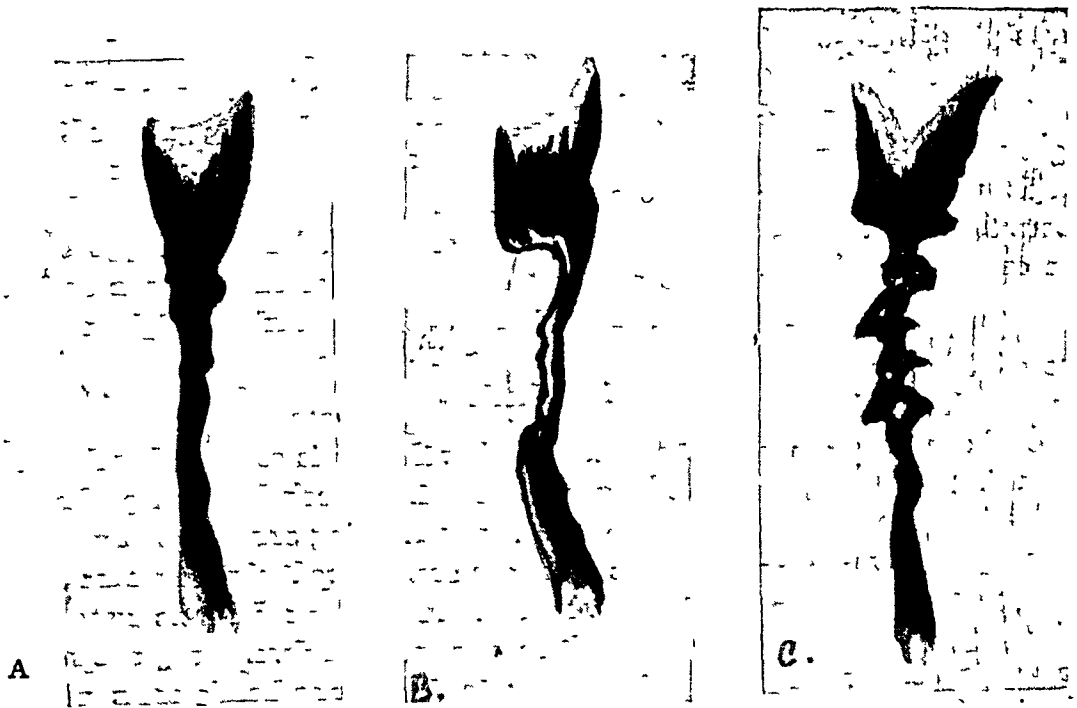


Fig. 1. Shows the three types of lesions as visualised clinically.

- A. Barium column as seen on the skiagram in the scirrhus type.
- B. The same in the polypoid type.
- C. The same in the ulcerative type.

LOCATION OF THE TUMOUR:--In 126 patients carefully studied:--

I. Above the bifurcation of the trachea	26
Above the clavicle ...	8
Below the     "   ... ..	18
II. At the bifurcation of the trachea	31
III. Below the bifurcation of the trachea	69
Above the diaphragm ...	55
At the cardia ...	14

It is seen that the majority of lesions occur below the bifurcation of the trachea and at this level. The upper and lower ends of the oesophagus were affected in 8 and 14 cases respectively.

THE TYPE OF TUMOUR:--Where this could be clearly identified on the skiagram.

Scirrhus 40;                      Ulcerative 27;                      Polypoid 38.

AVERAGE LENGTH OF LESION, as judged from X-ray studies.

Scirrhus 4.5 cm.                      Ulcerative 5.0 cm;                      Polypoid 7.0 cm.

This shows that the polypoid tumours tend to be more widely spread along the tube than the others and this is brought about by a submucous spread which is particularly prone to occur in this type of lesion.

#### DEGREE OF OBSTRUCTION

Slight	... 47
Moderate	... 49
Almost complete	... 9

#### DEGREE OF DILATATION

Nil	... 22
Slight	... 60
Marked	... 23

#### Pathology

Pathological specimens obtained at operation or at post-mortem conform to the three types that we see clinically. There is the stenosing scirrhus lesion which may extend over a small vertical segment of the tube; there is the flat infiltrating ulcer which may encircle the tube; and there is the polypoid growth that tends to grow into the lumen rather than through the wall and so often produces symptoms at an earlier stage of the disease. In the former two the tumour has frequently infiltrated through and outside the muscular wall when the symptoms first appear. The absence of a serous coat and the thin musculature of the tube are mainly responsible for the early penetration of the growth into the mediastinum. This makes it imperative that a radical surgical attack if it is going to have any chance of success should be early.

Distant dissemination is not commonly met with. - Most patients succumb before the disease has spread very far. The chronic malnutrition asso-

ciated with esophageal obstruction appears to undermine the patient's strength and resistance to intercurrent infections which carry him off before the cancer has had time to spread widely. In our series the lymph nodes frequently seen involved were those in the posterior mediastinum and those in the vicinity of the left gastric artery. This important lymph drainage from the lower half of the esophagus to the left coronary gastric group of lymph nodes, has to be remembered in radical operations on the organ for cancer. Involvement of cervical nodes occurs in a small percentage of cases. The liver is rarely involved and then usually from gastric lesions involving the esophagus.

Histologically, most of the tumours are of the squamous cell and epidermoid type and a few are adenocarcinomata. The Table below illustrates this :—

TABLE OF HISTOLOGICAL FEATURES

Squamous Carcinoma grade I	...	2
Squamous Carcinoma grade II	...	26
Epidermoid Carcinoma grade II	...	33
Epidermoid Carcinoma grade III	...	11
Adeno-carcinoma	...	2

It must be remembered that the esophagus is lined in the greater part of its extent by a stratified squamous epithelium. As one approaches the lower end, the lining gradually takes on the character of that of the gastric mucosa. The change is not abrupt and especially at the lower end the two types of epithelium dove-tail into each other. Therefore, whilst almost all the cancers of the upper part of the tube are squamous, some of the cancers of the lower end are adeno-carcinomata, so that it is often difficult to know whether the tumour originated in the stomach or at the lower end of the esophagus.

### Treatment

A reference to the results of the treatment of cancer of the esophagus with X-rays or radium reported from clinics all over the world and our own experience recorded below soon convince one that the results are far from satisfactory. There are only a very few cases on record that have been cured by radiation. The great majority of these patients die within one year of the appearance of the symptom or about from 6 to 8 months after the diagnosis. Watson<sup>2</sup> of Memorial Hospital, New York, reports 666 cases treated with X-rays at that hospital which deals only with neoplastic disease. Of these only 2 patients lived for more than two years and only 8 patients more than one year after the beginning of treatment. This sorry state of affairs has encouraged surgeons in recent years to tackle the problem on radical surgical lines. The first successful esophagectomy was

performed by Torek<sup>3</sup> of New York in 1913 on a woman of 67 years who subsequently lived for 13 years and died from pneumonia.<sup>4</sup> At post-mortem no trace of the old cancer was found. Since that time several successful resections have been done by surgeons all over the world. Till 1941 there have been reported in the world literature<sup>5</sup> 86 patients surviving the radical operation. Among these there are 10 who have lived for more than 5 years and 2 who have lived for more than 3 years. Garlock of New York reports 17 cases with a mortality of 27 per cent. Although these results are encouraging, the formidable nature of the operation and the high mortality attending on it raises the question whether it is a justifiable and worthwhile procedure. We have already pointed out that almost a 100 per cent of the patients treated with radiation die within a year. If, however, the early favourable cases are treated by surgical excision about 70 per cent of these would survive the operation, and of these at least 15 per cent would live for three years and over, a distinct improvement on present conditions. We must also remember that as esophagectomy becomes a more frequently attempted operation, the technique and mortality will improve, and better results obtained. One hesitates to advocate such a heroic operation in preference to radiation methods, but present results certainly justify it. One still feels, however, that the future of cancer of the esophagus must rest in the hands of the radiologist who should be able to evolve a technique which will give improved results. Until such time we believe that early cases that are willing to take the risk should be given a chance with surgery and those not inclined for the gamble subjected to improved methods of radiation technique. The greatest objection raised against operation is that the mortality is high and some patients who might have lived for some time are suddenly cut off. But this objection does not take account of the fact that the short period of life left to the patient is not particularly happy. Most of them have to have a gastrostomy for feeds, they cannot enjoy a meal; there is usually pain in the chest, and salivation, and foul breath from decomposing food mixed with discharge from the ulcer held up above the stricture; only a few of them have a comfortable time for a few months; almost all of them get worse and die in about from six to eight months. If the patient and his relatives would only realise how trying after all, these few months of life snatched from death could be, they would not consider surgery such a bad gamble at all.

As we have said before only a selected few should have a radical operation offered to them. In this selection we have adopted the following criteria.

- (1) With a short history of symptoms the chances of the lesion having spread beyond the limits of the tube are less and so patients with a history of over 3 months are considered not favourable though they are not excluded only on this account.

(2) A thorough examination should reveal no evidence of metastases. At the preliminary laparotomy to establish a gastrostomy or jejunostomy that is always done, a careful palpation of the liver, stomach, terminal esophagus, lymph nodes along the lesser curvature and the pre-aortic nodes is carried out. Any lesion in these situations, excludes the patient from radical surgery.

(3) The presence of a deep seated boring pain is interpreted as meaning extension of the disease into the mediastinum and is a contraindication for operation.

(4) Persistent fever is also indicative of mediastinal invasion and infection.

(5) The site of the lesion also influences the treatment. A growth at the lower end lends itself conveniently to a resection with preservation of continuity by a gastro-esophageal anastomosis. Apart from this, lower end lesions have been found to be comparatively radio-resistant perhaps because the viscera below the diaphragm interfere with adequate radiation, and partly because some of these lesions are the less radio-sensitive adeno-carcinomata. Disease at the aortic arch we treat with more surgical respect, as here there is apt to be difficulty with adhesions to very important structures and unless all the other factors are very favourable for an operation, we prefer to turn these patients over to the radiologist. Lesions above the aortic arch are not satisfactorily handled by surgery, because excision of that segment of the esophagus leaves too small a part of the tube for bringing out at the lower part of the neck. Lesions at the upper end of the gullet are more accessible to the X-rays and are perhaps better treated by radiation. The alternative of surgery involves a total laryngectomy as well, and plastic procedures to construct a cervical esophagus to bridge the gap in the neck.

(6) The nature of the lesion is also to be considered. Polypoid tumours tend to spread submucously and are therefore often seen early before any penetration through the muscle coat has occurred, and so are more favourable for resection than the scirrhus or ulcerative types. It is our routine to esophagoscope our patients and obtain a biopsy and if the histology shows a carcinoma of the higher grades 3 or 4, it is wiser to treat these with radiation as these are more radio-sensitive and are also more apt to disseminate early.

(7) The patient should be in fair general health, with a normal cardiovascular, renal and pulmonary apparatus. Unfortunately the majority of these patients are under-nourished and in poor health. However, we do not exclude patients merely on the fact of their being thin and emaciated as we have time and again been surprised to see how well these stand the operation, given expert anaesthesia, good team work in the theatre, sufficient blood

and plasma transfusions and meticulous attention to pre- and post-operative care.

### RADICAL SURGERY.

Patients who satisfy the above criteria are prepared for exploration and resection. Briefly, oral sepsis is attended to and protein, chloride and vitamin and water deficiencies corrected by intravenous plasma and saline transfusions and injections of vitamin C. The sugar reserve is built up by adding extra sugar to the diet. Two types of operations have now to be considered: resection and esophago-gastrostomy, and resection with bringing out of the upper segment at the neck.

*Resection and Esophago-gastrostomy.*—This is only possible in a lesion situated in the lower fourth, the upper limit being well below the root of the lung. In our experience there has been so much difficulty with the proximal segment, which retracts to an amazing extent, that we would hesitate to attempt an anastomotic procedure if the tumour were more than about 5 cms. above the diaphragmatic hiatus. In the average sized Indian we do not think it would be possible to effect a satisfactory anastomosis if the upper limit of the growth is less than 30 cms. from the upper incisor teeth as measured through the esophagoscope. When it is thought that an anastomosis is possible we prefer to establish a jejunostomy after the preliminary laparotomy. This is a great help in building up the patient for the second stage and also in maintaining nutrition during the early days of the second convalescence. A gastrostomy of course is avoided because it would interfere with the mobilisation of the stomach into the thorax at the major operation. Garlock sometimes dispenses with the jejunostomy preferring to feed his patient through a nasal feeding tube passed beyond the anastomosis. But we feel happier with the jejunostomy. At this first stage a careful inspection of the stomach, liver and adjacent nodes is made. If metastases are found the operation is concluded with a gastrostomy, and the patient treated by radiation.

The technique of the second stage will only briefly be indicated. The operation is begun as an exploratory thoracotomy and only if the growth is operable is the resection done. Esophagectomy is an operation that requires the assistance of an expert anaesthetist familiar with intrathoracic work. Our anaesthetist Dr. B. N. Sircar has acquired considerable experience of these operations. The technique he uses is intra-tracheal inhalation anaesthesia with ether or cyclo-propane with controlled respiration. The esophagus is approached transpleurally through the bed of the 8th rib which is resected upto almost the transverse process of the corresponding vertebra. We have so far never found it necessary to cut through any of the adjacent ribs to improve the exposure. The anaesthetist allows the lung to collapse and the latter is gently pushed out of the way with the assistant's hand to the lower part of the aorta and the diaphragm. Manual retraction preferable to the use of any retractor because the assistant can avoid



pressure on the heart. The esophagus is exposed by incising the mediastinal pleura in front of the aorta and the tumour inspected. In the presence of metastatic nodes or infiltration of the aorta or the adjacent mediastinum, the operation is given up and the thorax closed. If conditions are favourable, by careful finger dissection, the diseased segment is freed from its bed and the esophagus mobilised for about two inches above the growth. The diaphragm is then incised radially forwards from the hiatus and the stomach and spleen brought into view. The latter is held out of the way and the upper part of the stomach mobilised by dividing the short gastric vessels and the left gastric artery with their associated omenta. Particular care is taken to remove any nodes about the left gastric artery which is best tied at its origin. The stomach is then divided between clamps so that as much of the greater curvature as possible is preserved. The distal segment is sutured in two layers and kept ready for the anastomosis. It is better to complete all these steps first in order to minimise the time during which contamination of the pleural cavity may occur after section of the esophagus. The latter is then cut through at least one inch above the palpable upper limit of the tumour using no crushing clamps that damage the vascularity of the esophageal stump. The anastomosis is the most important step of the operation and must be meticulously done. The esophagus is implanted into an opening made into the anterior surface of the stomach at its highest part. A posterior layer of interrupted cotton sutures is placed to anchor the serosa of the stomach to the muscularis of the esophagus; a continuous catgut suture unites the mucosae; and an anterior interrupted cotton completes the anastomosis. Difficulty here is always caused by the retraction of the upper segment and after the anastomosis it is necessary to anchor the stomach to the pulmonary ligament and the adjacent pleura, to relieve tension on the suture line. The diaphragmatic incision is closed about the stomach with two or three sutures anchoring the latter to the former. A large drainage tube is then placed through a stab at the most posterior and dependent part of the pleural cavity and clamped. The thorax is then closed in layers taking special care to see that all air is expelled from the cavity by the anaesthetist inflating the lung fully before the last pleural stitch.

*Resection and cervical Esophagostomy.*—This operation is done in all cases of thoracic growths where the previously described procedure is not possible. A laparotomy is done as a first stage and the usual inspection for metastases carried out. Whatever the outcome of this exploration a gastrotomy is done. The second stage is undertaken a fortnight later only if the abdomen has been found clear of disease. The anaesthesia and position remain the same as described previously. The incision, however, is placed through the bed of the 7th rib and in one case it was found necessary to cut the posterior ends of the next two higher ribs to improve the exposure. After deciding that the condition is operable the tumour is mobilised with finger

dissection following incision of the mediastinal pleura in front of the aorta. It is also necessary to incise the pleura above the arch and to mobilise the esophagus from above. When the mobilisation is complete the esophagus is severed about an inch above the diaphragm and the lower segment inverted into the stomach. The stump of the upper segment is covered with a rubber envelope to prevent contamination, and the whole pushed up into the neck. This step is facilitated if the lower part of the cervical esophagus is freed from its bed by the finger working from the mediastinum. In this operation the greatest difficulty is met with from adhesions to the aorta and the opposite pleura and in four of our cases the latter was opened without any serious consequences however. A few twigs from the aorta to the esophagus have also to be tied but we have not so far experienced any trouble from severe hæmorrhage. The thorax is closed as described before and the patient turned over on to his back. An incision in front of the sterno-mastoid soon exposes the cervical esophagus and delivers the stump at the neck. The tumour is then cut off leaving a stump just sufficient to reach below the clavicle. This stump is then passed through a subcutaneous channel over the clavicle and allowed to open on the chest, where a few sutures anchor it to the skin. After a few weeks this stoma may be connected with the gastric stoma by a rubber tube so that the patient is enabled to take liquid food by mouth. At a much later date the connecting rubber tube can be replaced by a plastic skin tube, but so far we have had no opportunity to do so.

The number of esophagectomies that can be done in a year are very few, not only because the cases that are suitable are scarce but also because, to obtain consent for such a formidable operation the risks of which have to be explained to the patient's relatives, calls for eloquence and salesmanship of the highest order. We were able to achieve this happy combination on 16 separate occasions, so that we are able to report 8 esophageal resections and 8 exploratory thoracotomies.

TABLE IV. SUMMARY OF CASES TREATED BY RADICAL SURGERY.

I. Esophagectomy :—

(a) Resection & Esophago-gastrostomy : 4 Cases

3 patients died in the post-operative period.

1 patient survived for 10 months after operation ;  
was quite well for 8 months but developed  
a stricture with recurrence and died (case  
No. 2321)—See Fig. 2.

(b) Resection & cervical Esophagostomy : 4 Cases

3 patients died in the post-operative period.

1 patient survived 2 months but unfortunately  
was attacked with amoebic dysentery which

could not be controlled and led to his death.  
(Case No. 2450)

## II. Exploratory Thoracotomy :

8 Cases

5 patients survived and were later treated with X-rays; all of them succumbed within one year.

3 patients died in the post operative period; in these three an attempt at resection was made but given up after partial mobilisation of the esophagus or stomach.

As will be seen from Table IV our experience of radical surgery of the esophagus has been small. The results have not been particularly happy, but nevertheless the experience has been instructive. Of the successfully resected cases only two have survived. The others died post-operatively. Two died from shock. One died on the 7th day suddenly after a remarkably easy convalescence from sudden pneumothorax immediately after removal of the drainage tube. Two died from pneumonia and one from empyema on the 11th day. From the causes of post-operative death recorded above it will be seen that some of these fatalities could or might have been prevented and as one's experience increases one hopes to lose fewer cases, by improving technique and eliminating morbid factors.



Fig. 2. Skiagram of case No. 2321 after resection and esophago-gastrostomy showing stomach and anastomosis in the thorax. There is an anastomotic stricture. Picture taken 8 months after operation.

TABLE V. SUMMARY OF THE 153 CASES SEEN AT THIS CLINIC

X-ray treatment	...	39
Radium treatment	...	8
Radical surgery	...	8
Died after exploration	...	3
Did not return for treatment or took treatment for few days	...	48
Too far advanced for radiation	...	47
		<hr/> 153 <hr/>

### Management of patients not suitable for radical surgery

As has been said before only a few patients can be considered suitable for radical surgery. Therefore esophagectomy has practically a very small though definite place in the treatment. Most patients have to be treated palliatively with or without radiation. The first thing to decide is whether the patient should have any radiation at all. It often happens that the patient is so feeble that radiation would only hasten his end, and so such a one, or one with very extensive disease is only advised a palliative gastrostomy and his strength is maintained with a nutritious liquid diet, vitamins, liver extract and iron.

If the patient is fit for radiation we next decide whether he will need a preliminary gastrostomy. An individual who swallows even liquids with great difficulty requires a gastrostomy as the first step. A less obstructed person raises the question whether he should be carried through the period of radiotherapy without any preliminary procedures or whether his nutrition should be improved by a gastrostomy or dilatation of the stricture. It is our practice to try dilatation in the schirrhous lesion of short extent. The polypoid growth tends to bleed and the ulcerative lesion runs the risk of perforation if dilatation is attempted. A patient who may go along very well without any additional procedure is one with a polypoid tumour which sometimes shrinks sufficiently during radiation to relieve obstruction to a remarkable degree. The ulcerative type does best with a gastrostomy as the ulcer is kept at rest and secondary infection largely prevented by oral abstinence. We have carried a number of patients through radiation without a gastrostomy, but in many of these we have been compelled to perform it at some time or other because of return of obstruction usually from recurrence and in a few cases from post-radiational fibrosis.

*Gastrostomy.*—Most of the patients that need this operation are half-starved and dehydrated individuals and intravenous fluids to restore the water

and electrolyte balance, and vitamin C to promote wound healing are important pre-operative measures. We prefer in these cases a muco-cutaneous type of gastrostomy made by fashioning a goose-neck tube from the stomach wall and bringing it out through the abdominal wound so that mucosa and skin may unite. The advantage of this type of fistula is that it does not contract or close, and so permits the leaving out of the rubber tube except at feeding. The problem and technique of gastrostomy in cancer of the esophagus will be discussed separately by Dr. J. C. Paymaster at some length, so they will not be considered in this paper.

*Dilatation.*—In the scirrhus type of lesion where the patient is not acutely starving it is often possible to keep the stricture sufficiently patent with repeated dilatation during and after the course of radiation. The only indication for this is that patients prefer a procedure that permits them to chew and swallow food. We have used three methods in our cases.

(a) Dilatation through the esophagoscope under direct vision done at weekly intervals. Flexible tapering bougies of increasing sizes are passed through the stricture with care. This method besides subjecting the patient to an irksome procedure like esophagoscopy is also a little dangerous as the eye can only follow the bougie through the upper end of the stricture and cannot trace its further course which may occasionally be through friable tumour tissue into the mediastinum. We have therefore used this method rarely and only for post-radiational stricture.

(b) Passing dilators guided over a string previously swallowed is safer and less trying to the patient. The evening previous to the dilatation the patient is given 12 feet of string to swallow very slowly at the rate of about a foot an hour. This allows a large portion of the string to pass into the small gut and obtain firm anchorage there. The dilatation is performed by threading a series of graded metal olives screwed on the end of a flexible rod, one at a time, and passing them down the thread held taut with the other hand. In this way the dilator is made to follow the string in its devious track through the stricture. The passage is usually dilated to about 10 mm. just enough to permit swallowing with a fair amount of ease. We have usually used this method in our cases.

(c) Retrograde dilatation is done after a preliminary gastrostomy. The patient swallows a string with a small bead attached to its end. Through an endoscope passed through the gastric fistula the string is picked by a forceps. A series of graded rubber dilators are then attached to the string and pulled through the stricture from the mouth to give the required dilatation. This method is useful where dilatation over a string is not possible for any reason and where a patient already has a gastrostomy but wishes to have food by mouth. We have had occasion to use this method only once.

*Deep X-ray therapy.*—Most of our patients have been treated by X-rays with the following factors: 200 KV, 50 cm TSD, 15 ma,  $\frac{1}{2}$  mm Cu, 1 mm Al. Multiple ports of entry are used so that a large tumour dose may be given while the tissue dose to each segment of skin and lung is small enough to cause no damage. It is our practice to use 6 ports, 3 anterior and 3 posterior, each 3 cm in width, the vertical measurement being determined by the extent of the disease. The patient receives treatment daily through one or two of the ports in rotation. About 200 or 300 roentgens are delivered to each port and the total dose carried to 1800 r or 2400 r per port if the patient can stand it. The daily and total dosage may have to be reduced to suit the patient's condition. During the course it is most important to keep up the general health of the patient by careful attention to his nutrition and blood picture.

The results of X-ray treatment vary with the type and radio-sensitivity of the tumour. A polypoid growth often shrinks rapidly and opens up the lumen with considerable relief of obstruction and the patient can sometimes be carried through the treatment without any gastrostomy or dilatation. In the schirrus type of growth occasionally oedema and swelling of the tumour from radiation may increase the dysphagia and necessitate a gastrostomy and interruption of the rays. Most patients are benefitted by the radiation but many not as much as could be wished for. It is gratifying to see some who are able to swallow solid food for long periods. They may gain weight and live fairly contented lives for a few months. But these are very few and in almost all of these there is the inevitable return of symptoms sooner or later. Of all the patients treated with X-rays we have only two who are alive and well so far for more than two years, and only one passed the one year limit and died from recurrence soon after.

TABLE VI. RESULTS OF X-RAY TREATMENT

Received complete treatment	... 20
Received incomplete treatment	... 19
Alive and well more than 2 years	... 2
Survived more than 1 year	... 3 (including 2 above)

*Radium treatment.*—Radium has not been used much by us in the treatment of cancer of the esophagus. It has various drawbacks which will presently be discussed. Three methods have been used.

(a) *Intra-cavitary application.*—A Levine tube is passed through the nose, and, under the screen, the upper and lower limits of the growth are marked on the tube, so that the length of the lesion and its distance from the nostril are obtained. Radium capsules are then arranged in tandem over the required length and the tube passed into the esophagus and the position of the radium checked under the screen. Daily treatments lastings for from

3 to 6 hours are given to add up to the total dose decided upon. As it is impossible to measure accurately the extent and depth of the disease the tumour dose given so far has been empirical. A dose of 150 mg. hours per cm. length has been tried with satisfaction in one patient. The result obtained may be illustrated by the following case.

Case No. 3314 Mrs. B. G. aged 45, history of slight dysphagia of 2 months' duration. Fluoroscopy with barium revealed no abnormality. Esophagoscopy discovered a small segment of the anterior wall in the mid-thorax that did not move well on respiration. A biopsy from this revealed epidermoid carcinoma grade 2. Treated by above method with 1400 mg. hrs. in Jan. '43. Alive and well and able to swallow all foods when last seen on 5-1-'44.

Although a satisfactory result was obtained in the above patient the number of patients that are suitable for this treatment are few. It is only possible in those cases that permit the passage of a stomach tube. We do not like to use this method in the polypoid lesion because of the risk of bleeding. Only the short scirrhus lesion is best suited for this treatment. The great objection to this mode of treatment is that an adequate cancericidal dose cannot safely be given. If the outlying portion of the growth has to receive a sufficient dose the surface dose to the inner wall has to be so high that there is the risk of perforation from sloughing of this wall. Theoretically this treatment can only be proper in a very superficial lesion that has not penetrated far.

(b) Needling the growth through the esophagoscope is not a good procedure. Only the upper presenting surface can be so treated and the rest of the tumour is inaccessible. We have used it in only one patient.

(c) The insertion of radon seeds in the tumour after exposure through a thoracotomy is only useful in those cases where exploration reveals an inoperable condition. A major operation only for the purpose of placing radon seeds is hardly justified.

#### SUMMARY OF CASES TREATED WITH RADIUM

Total number of patients treated with radium	... 8
Treated by the intra-cavitary method	... 4
Treated by the insertion of radon through esophagoscope	... 3
Treated by radon after thoracotomy	... 1
Result—only one patient (Case No. 3314) alive and well for more than one year.	

From our experience and from a study of the literature we do not think radium applied locally is of much value in this disease. The only solitary worker who has reported fair results with it is Guisez<sup>7</sup> who has used it extensively and has a few patients alive and well more than 10 years. Other workers who have tried the same technique have miserably failed to even remotely approach his results.

After an experience of a large number of cases one realises that the problem of esophageal cancer still remains to be solved. This review of our cases emphasises the unsatisfactory state of things and calls for a more determined effort on the part of the radiologist to evolve a more effective technique. Until such time as this is found we would urge surgeons to attempt resections particularly in lesions at the lower end, where the outcome from the patient's point of view can be gratifying.

### Summary

(1) A review of 153 cases of cancer of the esophagus is given.

(2) The importance of early and careful radiological and esophagoscopic examinations is pointed out.

(3) The poor outlook from present day routine methods of treatment is indicated.

(4) A plea for radical surgery in suitable cases is made.

(5) An outline of the treatment carried out at the Tata Memorial Hospital is given and the various methods and their selection and application are discussed.

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# GASTROSTOMY IN CANCER OF THE ESOPHAGUS

BY

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Gastrostomy plays a very definite and important role in the treatment and management of cancer of the esophagus.

Its chief indications are :—

1. To permit proper and sufficient nourishment to the markedly emaciated and malnourished cases of cancer of the esophagus.
2. As a preliminary to X-ray or radium treatment.
3. As a first step to operative procedures on the esophagus.
4. To give rest to the cancer bearing esophagus ; causing less irritation and fermentation, and thus less pain and misery.
5. To allow retrograde esophagoscopy or insertion of radium tandem or any operative manipulations such as dilatation, etc.

A gastrostomy is said to be ideal when it fulfils the following conditions :—

1. It should form a gastric fistula which in no way is affected by the action of gastric juices.
2. It should be permanent and easy enough for the patient to insert a catheter and feed himself.
3. It should not allow any leakage of gastric juice or gastric contents.
4. It should permit gastric digestion unhampered :—not interfere with the physiology of the stomach and should not restrict the patient to bed.

If a gastrostomy is to be performed for cancer of the esophagus, the earlier it is done the better it is for the patient. It should not be put off till there is considerable loss of weight and strength. Its presence causes no discomfort in a case that is able to swallow liquids. The patient may defer using the stoma till obstruction supervenes.

There are several types of gastrostomy ; but very few meet the requirements stated above. The history of gastrostomy is interesting. In 1849 Sedillot described the earliest type of gastrostomy. It was a simple stomach cone brought up to the peritoneum forming a fistula through the abdominal

wall. This was far from being satisfactory because of the leakage, and hence numerous modifications were soon suggested. In 1891 Witzel created an intramural canal. Some years later Senn devised an inverted cone from the gastric wall by a series of inverting purse string sutures. A majority of these methods depended upon a tract lined by granulation tissue and required a constant inlying catheter to guard against stenosis or closure of the tract.

Noticing the futility of such methods, attention was now directed towards forming a plastic tube from the stomach wall itself. DePage in 1901 was the first to perform a plastic tube out of the anterior wall of the stomach. The base of the tube was placed towards the lesser curvature. Such tubes were usually short in length and so Hirsch in 1911 made a tube from the longer flap of the anterior wall of the stomach placed longitudinally, having the base towards the fundus. However, the blood supply of such flaps used to be very poor and many of the tubes sloughed away.

Jianu in 1912 devised a tube from the greater curvature of the stomach with the base at the fundus. The flap from which the tube is constructed has the left gastro-epiploic artery as its main blood supply. Finally in 1913, Janeway evolved his method of gastrostomy, utilizing a flap of anterior gastric wall with the base at the greater curvature. The plastic tube thus formed has a very good blood supply. It does not alter the shape of the stomach nor interfere with its physiology. A still better modification of the Janeway gastrostomy is the Spivak gastrostomy in which a fold of gastric mucosa is created by plicating the stomach wall at the base of the tube forming a valve which prevents leakage.

The most common variety of gastrostomy performed in our hospital is the Janeway type. A large number of the esophageal cancer cases come to us in a markedly low and dehydrated state. It is well worth the labour and time involved in combating this low state and dehydration by sufficient bed rest and repeated infusions of 5% glucose in normal saline.

Attention to teeth and supply of vitamins play an important part in pre-operative management.

The operation of gastrostomy is simple but yet so very important that we feel a detailed description of the operation is not out of place in this paper.

This operation is done under local anaesthesia. The line of incision and the rectus sheath are infiltrated with 1 per cent Novocaine solution and this anaesthesia is supplemented with intercostal nerve block on the left side with the same solution. The incision is a longitudinal one, situated over the outer half of the rectus muscle, beginning on the costal margin and extending downwards to a distance of 6 to 7 cm. The skin and superficial fascia are incised. The cut skin edges are then covered with skin towels. The anterior rectus sheath is incised and the left rectus muscle split in the direction

of its fibres. The manœuvre brings into view the posterior rectus sheath with the transversalis muscle. More Novocaine solution is now injected into the posterior sheath, reaching the peritoneum along the whole length of the exposed area. The posterior sheath and the transversalis are then divided longitudinally and together with them the peritoneum. The body of the stomach from which the plastic tube is to be made, lies directly under the upper portion of the left rectus and adjacent costal margin. Therefore, this short, left, midrectus incision brings easier access to this part of the stomach than any other incision devised. As soon as the peritoneal cavity is opened, two wet abdominal towels are so placed that they protect the cut edges of the wound. This step is very essential because in these devitalised and poorly nourished patients, if any spillage occurs into the cut tissues, a severe infection of the abdominal wall occurs, which may prove very serious.

A brief and limited exploration of the anterior surface of the liver, pre-aortic and perigastric regions for secondary deposits, is carried out. The stomach usually presents itself in the wound, if not, then with a smooth sponge holding forceps, and with constant but gentle traction, a sufficient portion is delivered through the wound to permit the entire operative procedure on the stomach to be done outside the abdominal cavity. When pain, discomfort and retching are complained of with this manipulation, a good plan is to infiltrate the gastrohepatic ligament with Novocaine. Having brought the stomach out, the abdominal cavity is shut off by two more dry abdominal towels arranged round the stomach. Care should be taken that the plastic tube is constructed from the body of the stomach rather than from the pyloric antrum. In the latter case, leakage and discomfort after feeds are very frequent. In our series of cases, on three occasions, tubes were constructed from the pyloric region of the stomach and these patients suffered a good deal of discomfort and leakage.

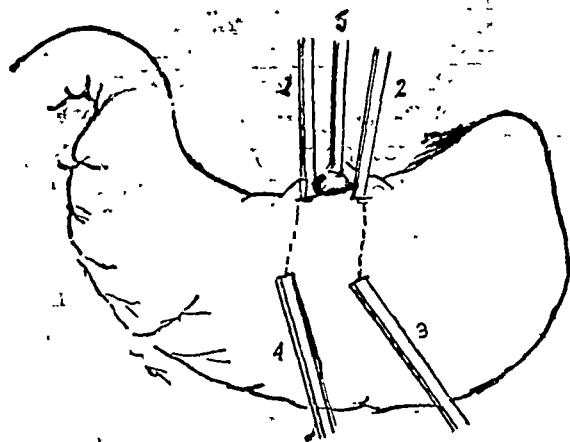


Fig. 1.

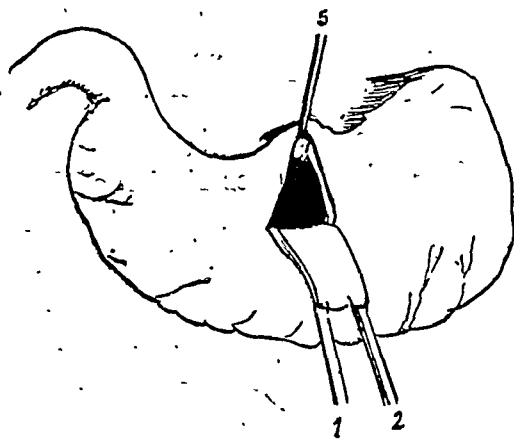


Fig. 2.

A rectangular flap about  $3\frac{1}{2}$  cm. long and 3 cm. wide with its base towards the greater curvature and its free edge at the lesser curvature is outlined by placing four Allis clamps as shown in Fig. 1. A fifth Allis clamp is placed opposite the mid point of the proposed free edge of the flap on the lesser curvature. The first incision is made at the proposed free edge of the flap which is parallel to the lesser curvature. The wall of the proposed flap is incised upto the submucous layer where numerous blood vessels are visualised. Formerly, we used to enter quickly the stomach cavity at one point and rapidly cut off the marked flap. But frequently we noticed that the bleeding was more than usual; thus, lately we have made it a point to catch most of the blood vessels running in the submucous coat on either side of the proposed incision into the mucosa. The stomach cavity is then entered at the free edge of the flap. The suction rod is placed in and the contents aspirated. From this point onwards, all the instruments that are used are placed on a separate towel and are discarded as soon as the stomach tube is constructed. With long straight operating scissors, the rest of the flap is cut out and few bleeding points left over are carefully caught and ligated. We use cotton thread J. P. Coates No. 50 to ligate blood vessels, and also to suture the muscular and serous coats. The mucous membrane is sutured with chromicised catgut. The fifth Allis clamp placed opposite the midpoint of the free edge of the flap on the side of the lesser curvature, marks the point where the suturing is to be commenced as shown in Fig. 2. The cut edges of the mucous membrane are carefully apposed by suturing with No. 00 chromicised catgut on a straight fused needle, using the continuous blanket stitch. Just before

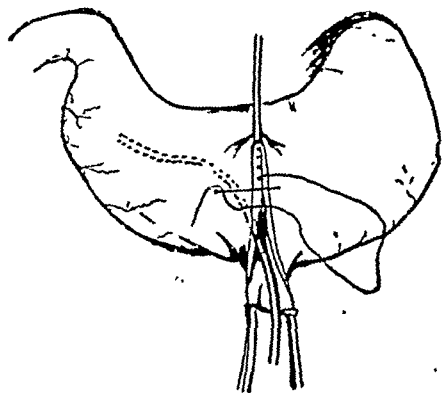


Fig. 3.

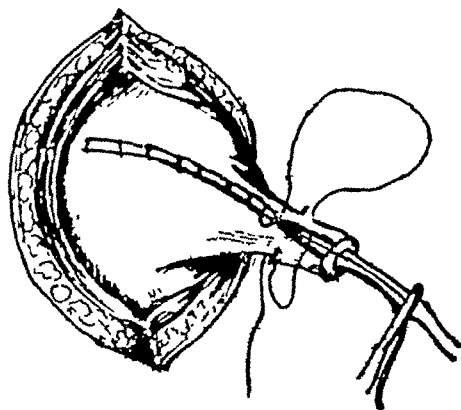


Fig. 4.

finishing the distal end of the tube, a catheter No. 14 (French) is introduced into the stomach cavity. Formerly, it was the practice to pass the catheter

of acid gastric contents. Relief is obtained by neutralizing the acid with soda bicarb compresses and keeping the irritated skin covered with Zinc Oxide paste.

### MANAGEMENT OF GASTROSTOMY FEEDS

This is a very important problem needing constant care and adjustment of feeds to suit the disorganised and weak digestion of these patients.

Feeds are slowly and gradually worked up to the full quantity. For the first 48 to 72 hours, small quantities of water or peptonized milk are given through the tube and the rest of the fluid intake is made up by intravenous 5% glucose in normal saline.

It has been estimated that a person not doing much physical or mental work requires in 24 hours, food having a value of 2400 calories. By careful study and observation of the weights and state of nutrition of our cases, we have, in association with the department of biochemistry, evolved the following formula for our gastrostomy cases. In 24 hours each person needs the following :—

Buffalo-milk	..	..	... 40	ozs.
Water	..	...	.. 20	ozs.
Wheat flour	..	..	.. 2	ozs.
Sugar	..	..	.. 6	ozs.
4 whole eggs & 4 whites of eggs, salt 4 drachms				
& Iron in some form, about				.. 10 grains.

The above formula is divided into the following convenient feeds ;

#### *Feed at 6 a.m.*

2 eggs, 8 ozs. buffalo-milk,  $1\frac{1}{4}$  oz. sugar, a pinch of salt and juice of an orange.

#### *Feed at 10 a.m.*

1 egg & 1 white of egg, 8 ozs. of milk, 4 ozs. of wheat porridge (2 ozs. of flour mixed with 20 ozs. of water allowed to boil for 30 minutes till the quantity reduces to 16 ozs. and the resultant divided into four equal feeds)  $1\frac{1}{4}$  oz. of sugar, a pinch of salt and iron in some form. In our hospital we use 1 Tablet Fersolate.

#### *Feed at 2 p.m.*

1 white of egg, 4 ozs. of wheat porridge, 8 ozs. of milk,  $1\frac{1}{4}$  oz. sugar, a pinch of salt and juice of an orange.

#### *Feed at 6 a.m.*

1 egg and 1 white of egg, 4 ozs. of wheat porridge, 8 ozs. of milk,  $1\frac{1}{4}$  ozs. of sugar, a pinch of salt.

Feed at 10 a.m.

1 white of egg, 4 ozs. of wheat porridge, 8 ozs. of milk, 1½ ozs. of sugar and a pinch of salt.

On such a formula, patients have steadily increased in weight and improved in general health. In cases of decrease in weight the quantity of feed is increased till improvement occurs in weight and general condition. If diarrhoea supervenes then feeds are cut down and gradually built up.

Before discharging the patient from the hospital, he is taught how to prepare his feed and the method of feeding.

On reviewing the first 5000 cases recorded at the Tata Memorial Hospital, we noticed that there were 153 cases of cancer of the esophagus. The following Table indicates the type, the number, the indications and the mortality and morbidity of gastrostomies done at our hospital.

Type of Gastrostomy	Number (Total 66)	Time and indication	MORTALITY (Total 8)	Morbidity
Janeway	42	Pre-operative 6 Pre-radiation 28 In course of radiation 6 After completion of radiation 2	(3 cases died) 1 died on 8th day from coronary thrombosis. 2 died from debility within 8 days.	Wound infection was present in 16 cases out of 66.
Spivak	16	Preoperative 1 Pre-radiation 14 In course of radiation 1	(3 cases died) 1 died from Pneumonia within 6 days. 2 died from Peritonitis, both on the 8th day.	
Jianu	4	All pre-radiation	1 died from debility & infective enteritis.	
Senn	4	Performed in very feeble patients with extensive disease.	1 died from Pneumonia on 6th day.	

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# ANAESTHESIA FOR THE SURGERY OF THE ESOPHAGUS

BY

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Regions of the body which were for a long time considered inaccessible to surgical intervention are now being successfully operated upon. In this category the esophagus holds a prominent place. The conduct of anaesthesia for the surgery of the esophagus will be greatly influenced by the anaesthetist's knowledge of the physiology of respiration. The general principles of anaesthesia are the same whether the site of operation be the esophagus, the lungs or the heart, i.e., the management of anaesthesia in the presence of pneumothorax.

A study of the effect of pneumothorax in the physiology of respiration will give an idea of the anaesthetic technic to be used. When one of the pleural cavities is opened widely by operation, the negative pressure surrounding the lung is supplanted by atmospheric pressure, the lung collapses, and the mediastinum with its contents is pushed to the opposite side.

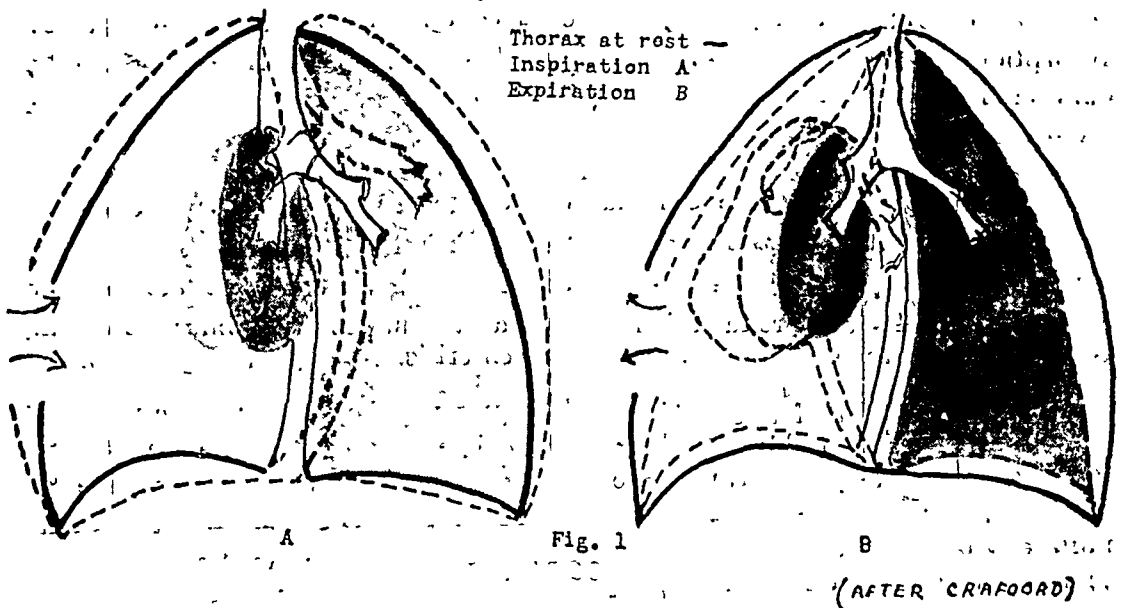


Fig. 1 shows the alterations in the physiology of respiration during inspiration and expiration when one of the pleural cavities is opened widely.<sup>1</sup> During inspiration air rushes in from the outside through the trachea into the lung on the sound side due to expansion of the thorax and increased negative pressure in the lung. As soon as the intrapulmonary pressure on the

sound side becomes more negative air flows in also from the lung on the opened side into the lung on the sound side. During expiration the increased pressure blows the air out of the functioning lung. When the air passes the carina a part of it flows back into the lung on the opened side where the pressure is still reduced and a part of it passes out through the trachea. At the same time, the mediastinum shifts back and forth with each cycle of respiration, disturbing the heart and great vessels. It will be seen from this that the obvious result of the paradoxical respiration is low tidal volume and impaired gas exchange.

The problem of controlling intrapulmonary pressure and paradoxical respiration occupied the attention of Thoracic Surgeons and Anaesthetists for many years and resulted in the use of several ingenious devices and methods for anaesthesia. Negative pressure chambers, constant flowing positive pressure gas anaesthesia machines and rhythmically working respiratory pumps were developed in order to correct these respiratory changes and shifting of the mediastinum.

Recently a new technic called "controlled respiration"<sup>2</sup> is being used by anaesthetists for open-chest anaesthesia. Controlled respiration is a term applied to a condition where pulmonary ventilation is under the control of the anaesthetist, i.e., respiration is passive on the part of the patient and active on the part of the anaesthetist. Three factors are essential to its attainment: (a) the production of apnea by over-ventilation, using the carbon dioxide absorption technic, (b) the continued suspension of all respiratory efforts by maintenance of proper ventilation and (c) the ability to start the automatic breathing at will.

The production of initial apnea is brought about as follows: when the cyclopropane or ether anaesthesia is established and intratracheal intubation performed, the breathing bag is squeezed gently during the latter half of each inspiratory phase of respiration. As a result of this hyperventilation the  $\text{CO}_2$  content of the blood is decreased and fails to stimulate the respiratory centre to initiate the contraction of the respiratory muscles. Within a short while all respiratory movements cease, the anaesthetist, then, maintains ventilation by manually compressing the breathing bag to effect inspiration. Expiration is accomplished by the elastic recoil of the lungs. The anaesthetist should imitate what he believes to be the normal exchange for the particular patient. The depth of anaesthesia and the use of controlled respiration technic should be such that normal automatic breathing should start within a minute after the manual compression of the bag is stopped. Sometimes removing the soda-lime and continuing the ventilation starts the normal breathing.

We have used exclusively this principle of controlled respiration in the anaesthesia for the surgery of the esophagus.



No. 5263

## TATA MEMORIAL HOSPITAL

Ward. 147

## ANESTHESIA RECORD

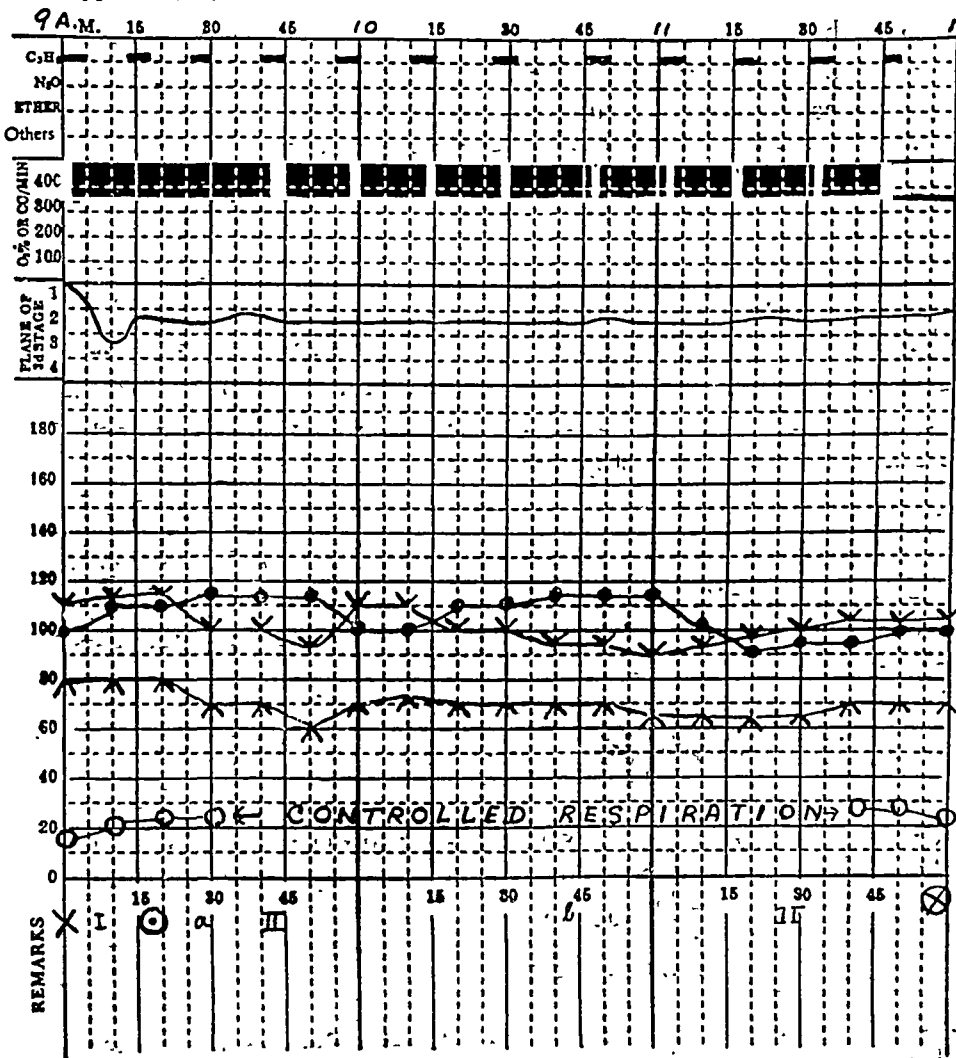
Date. 4.10.43

Name. Mr. G. Age. 58 Time. 9:00 AM O.R. I

Op. Proposed. Trans-thoracic Oesophago-gastrostomy Surgeon. Paymaster

Anes. Hist. (Neg) S. U.

Premedication. Morphine gr 1/6 and atropine gr 1/150 at 7:30 AM



Agents: Ind. Cyclopropane - Oxygen Maint. Cyclopropane - Oxygen  
Tech. Ind. Absorption Maint. Oral & cuff. Abs. Reflex in O.R. Yes. No. ✓  
Operation. Trans-thoracic Oesophago-gastrostomy Vomil. ....  
Surgeons. PAYMASTER - BORGES - MEHER-HOMJI - JUSSAWALKA Excit. ....  
Anesthetists. SIRCAR Others. CO<sub>2</sub> used after question to work with collection bag.

*Anaesthetic agent.*—Cyclopropane has been the anaesthetic of choice as suggested by Rovenstine.<sup>3</sup> This particular agent has been selected because of certain advantages. Both induction and recovery of anaesthesia are pleasant and quick, respiration is not stimulated, mucous membrane irritation is absent and a high concentration of oxygen can be administered.

*Technic.*—The technic begins with pre-operative medication—a dose of morphia and atropine in the ratio of 25 to 1, i.e., morphia gr.  $\frac{1}{4}$  and atropine gr.  $\frac{1}{100}$  has been used routinely an hour and a half before operation. The administration of a barbiturate on the day of operation has not been our practice. The patient is then anaesthetised with cyclopropane and oxygen by Waters' "to and fro" carbon dioxide absorption technic. When the desired depth of anaesthesia is reached an oral intratracheal intubation is done with "direct-vision" laryngoscopy. A Magill tube with Waters-Guedel cuff is used to seal off the trachea. The patient is then turned to the right lateral position for surgery. When the surgeons are about to open the pleura the anaesthesia is then administered by the controlled respiration technic. This method is continued throughout the operation till the pleura is again closed. During the surgical procedure the left lung is kept collapsed for exposure of the esophagus, hence it is necessary to inflate the lung every ten minutes when surgery should be temporarily stopped.

It has been our practice to do a tracheo-bronchial aspiration before the patient is sent to the ward. Oxygen has also been administered routinely either by the oropharyngeal catheter or by the oxygen tent.

Fig. 2 shows the anaesthetic chart of a case of trans-thoracic esophago-gastrostomy done with cyclopropane anaesthesia and "controlled respiration" technic.

### Summary

Anaesthesia for the surgery of the esophagus as practised in our clinic has been described. The problem of pneumothorax and its effect on the physiology of respiration has been fully discussed.

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## INJURIES OF THE THORAX\*

(Continued from Vol. VI, No. 2.)

BY

C. S. PATEL, F.R.C.S. (ENG.)

### Injuries of the Heart

Surgery of the heart has rapidly evolved during the past 30—40 years as a result of the attempts made in the treatment of wounds of the heart. We must consider the heart and pericardium together because they are so intimately associated that the injuries usually affect both of them.

The heart is fairly well protected from any ordinary type of trauma. This is due mostly to its position in the thoracic cavity—protected by the sternum. Many mild injuries of the heart escape unrecognised.

My personal experience of injury to the heart amounts to three cases only: one with a tear in the pericardium without hemopericardium, the second with a tear in the pericardium and a superficial wound of the right ventricle with a small collection of blood in the pericardial cavity and the third of a stab of the left ventricle with hemo-thorax and hemo-pericardium. The first two cases survived while the third one died.

Injuries of the heart fall into two groups—non-penetrating or subcutaneous and penetrating or open.

#### NON-PENETRATING INJURIES

These injuries usually result from contusions and crushes of the chest and the damage to the heart may vary from minor and temporary disturbances of function to extensive contusion and laceration of the heart muscle. Such injuries may result from (1) blows over the precordium, (2) compression of the heart between the anterior chest wall and the spine as in runover accidents, (3) indirect violence as a result of sudden compression of the thigh on the abdomen as happens in parachutist accidents and falls from great heights, and (4) as a result of blast injuries.

The condition of the heart—systole or diastole—at the time of the impact determines the damage—more damage being caused during systole. A diseased wall of the heart will naturally give way more easily than a healthy one.

Apart from visible injury, there is an imperfectly understood condition "or a concussion of the heart. In this condi-

tion there are produced disturbances in the function of the organ without any demonstrable changes in the structure of the heart. Sometimes there are minute contusions in the muscle. These disturbances are attributed to nervous or vascular changes; but proof of this is lacking. Precordial discomfort amounting to pain of anginal type with dyspnoea and cyanosis are present. The patient is usually restless and there is much precordial distress. The pulse is weak and irregular. The diagnosis is made from the above symptoms, following the injury and from the history of the previous good health of the patient. The treatment consists in giving absolute rest till normal function of the heart is restored.

Contusion of the heart muscle is associated with disturbances of structure and function such as dilatation of the heart, tachycardia, arrhythmia and heart block. The contusion may heal by absorption of blood and subsequent connective tissue formation and cicatrization. Such a contused area may rupture if further force is applied to it, before healing occurs. Aneurysm may develop in the area so affected.

The signs and symptoms of a contused heart are pain over the precordium, cardiac distress, restlessness, cyanosis; weak pulse and weak heart sounds. Heart block is of frequent occurrence. A valvular murmur may sometimes be heard. X-rays may show an enlarged cardiac shadow due either to dilatation or pericardial effusion. Electrocardiogram often shows definite changes.

Treatment consists in complete rest and in cases showing marked pericardial effusion, paracentesis pericardi or pericardiectomy will have to be seriously considered.

Cardiac rupture may occur as a result of the various compression injuries already mentioned. As a result of the compression, the heart bursts at its weakest point, and it has been found that all the four chambers are about equally involved, though according to Peacock and Newton, the left ventricle and right auricle are more affected than the right ventricle and left auricle. Occasionally a rupture may be multiple. The pericardium may or may not be ruptured at the same time. Death occurs almost instantaneously in most cases. In those that survive, shock is pronounced. There is very severe precordial pain and fear of impending death. In those cases in which rupture occurs with an intact pericardium, cardiac tamponade takes place. In this condition blood escaping from the heart accumulates within the pericardium. The normal capacity of the pericardial cavity is about 200 to 300 c.c.; but it can accumulate a very much larger quantity, provided the accumulation occurs slowly. When the accumulation occurs rapidly, as in rupture of the heart, pressure symptoms arise. These result from pressure on the thin-walled auricles and veins and also from angulation of the veins produced by the forward displacement of the heart by the accumulated blood. The weight

of the distended pericardium also contributes to this effect. As a result of the compression of the auricles and veins, the venous blood cannot enter the heart and accumulates in the systemic veins. The patient is extremely restless, perspires profusely and his body surfaces are cold. His face which was pale, due to shock before, becomes cyanosed and the veins of the neck and head are distended. The liver is enlarged. The pulse which was rapid at first becomes weak, irregular and fluttering. There is much oppression in the precordium and fear of impending death. The blood pressure falls and the patient soon becomes unconscious. On examination of the heart the cardiac area is increased and the heart sounds are muffled, obscure or even absent.

Treatment of a ruptured heart is rarely possible because death occurs instantaneously in most cases. In those that survive the initial period, an open operation with suture of the rupture may be undertaken. In all cases of cardiac tamponade, an operation should be promptly undertaken, even in most desperate cases because as soon as the pericardium is incised and the pressure relieved, the heart action improves.

Besides concussion, contusion and rupture of the heart, other internal cardiac injuries have been noticed as a result of trauma. Rupture of the papillary muscle has been described. Senac has described a case of traumatic rupture of a valve. The aortic valve is much more often ruptured than the mitral and the tear in the valve occurs usually as a prolongation of a tear in the chorda tendinea, or the papillary muscle. Rupture of the pulmonary valve is an extremely rare condition. Prognosis of these cases is extremely grave. If they recover, aortic and mitral incompetency results as a permanent sequel. Treatment consists in absolute rest and medical treatment.

Dislocation of the heart due to extensive tear in the pericardium has been described to occur into one of the pleural cavities. X-ray clinches the diagnosis. Thoracotomy and replacement of the heart in its proper position should be the line of treatment adopted. Various sequelae, like auricular flutter, auricular fibrillation, extra systoles and varying degrees of heart block have followed the non-penetrating injuries of the thorax where cardiac involvement has occurred. These injuries are often not sufficiently recognised and the diagnosis is not often made. The medico-legal importance of these injuries necessitate a careful study and close observation of these cases. X-ray pictures and electro-cardiograms are of great value in the diagnosis of the heart conditions following trauma.

#### PENETRATING INJURIES OF THE HEART AND PERICARDIUM.

Penetrating wounds of the heart are much more common than non-penetrating ones but very few attain surgical importance as most cases end fatally on the spot, or a little later, and very few cases come to the hospi-

tal for surgical aid. Gunshot wound of the heart will seldom be an isolated lesion and it is often accompanied by severe damage to other thoracic organs. The wounds of the heart in warfare are often extensive. Rarely the heart may be blown to pieces. Severe laceration may be caused by missiles which pass through and through the organ or they may be lodged in one of the cavities of the heart. War wounds of the heart may be aseptic or carry with them sepsis of a very severe degree. Gunshot wounds of the heart are instantaneously fatal. Hardly one or two per cent. of the penetrating wounds of the heart belong to the category where surgical treatment is possible. The majority of these wounds are usually stab wounds and few of these are amenable to surgical treatment.

Penetrating wounds of the heart are caused by pins, needles, cutting weapons like knives, daggers, etc., missiles, bullets, shots, shells or shrapnel fragments. Wounds caused by pins and needles are not of very great consequence as contraction of the musculature of the heart usually closes the track caused by the needle. I remember a case of an injection needle being broken into the heart during a successful attempt at resuscitation and left in situ. This has led to no serious consequences afterwards. Injuries of this type may prove serious if a vital part of the heart including a coronary vessel has been penetrated. Possibility of a natural recovery is greatest in punctured wounds caused by needles or pins, while in wounds caused by gunshot, missiles or knives, the possibility of natural recovery is much less, as there is usually too great a destruction and laceration of the edges of the wound to promote natural healing. The right ventricle is more often involved by stab wounds caused by knife or daggers, while the left one is more frequently involved in gunshot or bullet wounds.

In the majority of cases there is usually an association of pneumothorax and laceration of the left lung which complicates the diagnosis and influences the prognosis of the wounds of the heart. In the rare event of a missile entering through the inferior vena cava, there is no wound in the pericardium; in all others there is always at least one.

Penetrating wounds of the heart end fatally in the vast majority of cases. This is due either to failure of circulation resulting from the destruction of the organ itself or to the destruction of the conducting system—sino-auriculo-ventricular nodes and bundles. If they survive, haemorrhage is one of the most serious effects of the wounded organ. Blood collects in the pericardium and escapes into pleura or to the exterior. Haemorrhage is so severe that death usually occurs soon. If the wound in the pericardium is small, the blood cannot escape outside, cardiac compression supervenes and if not relieved, leads to a fatal termination.

Endocardiac thrombosis at the site of the lesion may occur and pieces of clots may be swept into the circulation, giving rise to embolism in various regions of the body.

## SIGNS, SYMPTOMS AND DIAGNOSIS

There is a great deal of variance in the clinical picture of each individual patient; so it is difficult to give a comprehensive symptomatology of those causes. It is astonishing to note that sometimes the patient remains in an apparently good condition inspite of a very severe wound of the heart. They walk distances and come to the hospital. Small pricks in the heart may not produce any appreciable symptom.

## CASE NOTES

A patient was brought to the operation theatre during a riot day with all his clothes soaked with blood and a penetrating wound in the chest wall in the left fourth intercostal space about  $2\frac{1}{2}$  inches from the midsternal line. The wound was oozing a little blood, his limbs were cold, clammy and perspiring all over. The pulse was fast. I was busy with another urgent operation for large and progressive haemorrhage in the pleural cavity due to a stab in the lung and it took about 20 minutes before this patient could be taken up for operation. A large incision in the fourth intercostal space was made and the fourth rib was detached from the costochondral junction. Rib-spreader forcibly opened, gave an excellent view of the lung, heart and the pericardium. There was a gush of blood every now and then from a torn pericardium into the pleura. The pericardial wound was rapidly enlarged and a wound was noticed in the left ventricle about an inch long and blood pouring into the pericardium with each systole. The bleeding from the heart was controlled quickly by the Sauerbruch grip and the wound sutured by four stitches. The pericardium was swabbed out and sutures were applied to the wound in the pericardium. The pleural cavity was cleaned out and blood clots were removed. The ribs were approximated by pericostal sutures applied at intervals. The wounds in the chest wall was closed finally. The patient died in the ward after two hours. This case has been mentioned here as an illustrative case showing that the injury, though it did not look so serious, proved extremely serious on exploration of the thorax.

The situation of a wound over the proecordium or round about will indicate the possibility of a wound involving the heart. Cardiac wounds may be found even in cases of bullet wounds situated in the lateral wall of the chest, in the axilla, or the shoulders.

Patients are usually pale, cold and collapsed. There is marked perspiration and a very rapid pulse. Shock is much pronounced. Increasing pallor, air hunger, increased pulse-rate and low-volume-pulse are also signs of internal haemorrhage. It is only after the treatment of shock has been carried out that some clue to the diagnosis of the cardiac injury may be had. Persisting pallor, persisting sweating and persistent cold and clammy skin with a feeling of suffocation and precordial pain, associated with an anxious look, cyanosis, and dyspnoea, and a weak imperceptible low volume pulse are some of the pathognomonic features of cardiac wounds. This will be further confirmed if the clinical picture of cardiac compression is associated with physical signs of a large haemothorax. Great spurts of blood gushing out of the large gaping wound of the thorax at each cardiac beat, is indicative of a fairly

large size wound of the heart. In addition to these, premonition of death, restlessness and thirst are other associated symptoms indicating a heart lesion. The heart area may be found to be enlarged on percussion. The apex beat is not usually palpable either due to hemo-pericardium or to feeble cardiac action.

The heart sounds are diminished and give an impression of a quiet heart. Mill-wheel murmur may be found on auscultation and is recognised by metallic and splashing sounds like those produced by a water-mill and synchronous with the movements of the heart. These sounds are also found in injuries of the lung. So they are not of great value.

X-ray examination reveals air or fluid in the pericardium. Enlarged shadows of the heart may also be found. Kymography records will suggest a relatively immobile heart. In less dangerous cases electrocardiographic record will give some help. Prompt treatment will have to be instituted and exploration should be done immediately to save the life of the patient without submitting him for investigation.

#### TREATMENT

There will be a class of patients which requires no treatment except a close observation for the possible development of signs and symptoms indicating damage to the heart. There is another class of patients where nothing can be done to save life as they are in a hopelessly bad condition. Wounds caused by pins and needles, generally speaking, may not demand any special treatment. There is a class of patients for whom urgent surgical intervention is necessary to avoid fatal termination resulting either from internal haemorrhage or from cardiac compression. Stab wounds penetrating the heart will always require an immediate operation. If a bullet has been lodged in the heart and remains there without causing much symptoms, it should not be disturbed. A number of bullets have remained in the heart without causing much trouble. The only danger attendant in such cases is the formation of emboli. Spontaneous healing of heart wounds does occur particularly if the wounds are superficial and affecting a thick-walled ventricle; an instance of this I have already quoted in the beginning.

The mortality of operations on the heart was extremely appalling upto the end of the last century amounting to 80 to 85 per cent; during the present century, particularly during the last 30 to 40 years, specially during and after the great world war, the mortality of these operations has been considerably reduced. This is due to early diagnosis, institution of prompt measures, and improved technique of operations. Various workers in this field have collected details and the mortality varies from 35 to 65 per cent.

Increasing pallor, symptoms of cardiac compression and low pulse



volume demand an urgent operation. If time permits, restorative measures like warmth and infusion of fluids subcutaneously may be given prior to operation. A blood transfusion or auto-transfusion of blood collected from the pleura or the pericardial cavity should be given during operation if the hæmorrhage is severe. The question of infection resulting from the auto-transfusion of blood should not be considered a bar to its administration as it is a life-saving measure.

#### APPROACHES TO THE HEART

A number of surgical approaches to the heart has been suggested by numerous workers. The most important of these are :—

- (1) A long intercostal incision made by enlarging the parietal wound.
- (2) Midsternal incision.
- (3) Parasternal resection of cartilages and formation of chondroplastic flap.

The long intercostal incision is to be preferred to the other approaches in cases where the pleural cavity is open. It is quite a simple incision and gives a sufficient exposure to the pericardium and the heart. Injuries of the lung are also well visualised and the heart is very rapidly approached through this incision. A brief description of this operation has already been given under the heading "Lungs and Pleura."

Some consider that the parasternal incision is much better, particularly because the wound does not involve the pleural cavity and keeps it free from infection if it occurs, while giving an excellent approach to the heart. This incision lies along the middle of the sternum and passes outwards along the sixth costal cartilage to the mammary line. At the upper end the incision is extended horizontally over the third rib cartilage. The structures from the front of the sternum are separated till the costal cartilages are exposed. The 3rd, 4th, 5th and 6th costal cartilages are divided at their sternal ends. This flap is lifted up slowly and gently the cartilages fractured at their junctions with the ribs, the pleura being pushed outwards and downwards. The pericardium will be recognised by its glistening surface. If more room is required, the remains of the sternal ends of the costal cartilages and even a part of the sternum may be cut away with rongeur forceps.

The midsternal route consists in splitting of the sternum vertically in the midline. This is a severe operation and does not give any additional advantages. Besides, this requires special instruments.

Intercostal incision with detachment of the fourth rib from the costo-chondral junction and sometimes the fifth, with wide separation with rib-spreaders is a method of choice I have used in all the cases. I have come across no difficulty in having sufficient exposure or proper exploration of heart

wounds. Very rapid operation, preservation of rigid asepsis and quick decision as to what to do during the operation are essential for the success of the operation.

The pericardial incision is enlarged and edges are held apart by tissue forceps. The blood is rapidly sucked out by an electrical sucker. The heart is found to be moving and difficult to handle. For examination the organ may be pushed this way or that, gently, or may be rotated partially with care without any disturbances in the cardiac action. It is only when it is lifted forwards or twisted forcibly or handled at the base that its action becomes irregular and tumultuous or ceases altogether.

### THE METHODS OF CONTROLLING BLEEDING DURING OPERATION

In cases of blood gushing out with every contraction of the heart it becomes difficult for the operator to recognise and to suture the wound. Bleeding from the heart during operations can be controlled by a number of methods of which two are most important: (1) If the wound in the heart is small, a transfixion suture is passed through the apex of the heart, and is held in the left hand to steady the organ, with the forefinger of the left hand placed over the wound as recommended by Ballance. If the wound is large this method is not satisfactory.

(2) The Sauerbruch grip is the method of choice to control bleeding in cases where the wound of the heart is large and aims at the temporary compression of atria and venae cavae. This may be secured by passing the middle finger of the left hand into the transverse sinus with the ring little fingers placed behind the heart. If these two are approximated, temporarily, the blood return to the organ is arrested. The grip should now and then be relaxed to allow some blood flow to the heart. The index finger and the thumb may be advantageously used to demonstrate and steady the wound in the heart.

Some operators press the base of the heart against the sternal border while others exert pressure on the right auricle. The method of putting the finger directly into the wound itself has been recommended by some. This has serious disadvantages. It will not only enlarge the wound but it will unnecessarily increase the time for suturing. Besides it will be difficult to apply sutures as the fingers come in the way.

Application of the tip of the finger is the best method of controlling the bleeding if the wound in the heart is small. If this does not control efficiently, a stitch should be placed into each edge of the wound and the ends of the stitches are crossed over till the final sutures are passed. If the bleeding is very profuse, the Sauerbruch grip is the only course left to the operator.

After the bleeding is controlled, No. 2 or 3 chromic catgut sutures are passed through the muscle with a round bodied needle. These are placed at intervals of about a quarter of an inch, and taking quarter of an inch of wall from its edges. Sufficient care should be taken not to damage any coronary vessels. Sutures should not pass through cavities of the heart. Sutures should not be too tight and should not include too much tissue. The suture should be tied during diastole preferably, but in my opinion it does not matter in what phase of the cycle the sutures are tied. A muscle graft may be included to arrest bleeding in some cases and the sutures tied over it.

During the manoeuvre, if the heart ceases to beat, allowing the organ to go in its own position, stroking its surface, by applying gentle pressure on the ventricle or massage and intracardiac injection may start the function.

Careful search is made for foreign bodies like missiles prior to the closure of the heart wound. If the missile is present and is easily felt in the cavity of the heart, an attempt may be made to remove it. The missile is coaxed to come out rather than forcibly withdrawn. Great care is taken not to inflict a further tear in the heart. Foreign body in the pericardium is to be treated in the same way. The foreign body which is embedded firmly in the heart wall or its cavities, should be left alone.

The pericardial sac is again cleaned out of blood with a swab and immediately sutured with continuous catgut stitches, with or without drainage as the condition demands.

Other injuries in the lung, pleura, etc., if found, are immediately dealt with. Ribs are approximated by passing at intervals 4 to 5 pericostal catgut sutures. Muscles are sutured as usual and the rest of the wound is closed.

Post-operative care consists in perfect rest. Transfusion or intravenous glucose saline should be avoided in order to limit the venous return to the heart. Infection of the pericardium and pleura should be closely watched for and early treatment in a needful case should be undertaken. Pneumonia, mediastinitis, and spread of infection to systemic circulation are complications which may end the patient's life. Endocardial thrombosis and embolism have been recorded.

Prognosis of a patient with heart wounds is certainly grave but howsoever bad the patient may look, operation should be performed and once the cardiac compression is relieved, the wound repaired and the bleeding arrested there is every possibility of his recovering. The results of the repair of the wounds of the heart are on the whole very satisfactory. Precordial pain, angina, irregularity of the heart and other sequelae may follow operations on the heart.

### Injuries of the Mediastinum

Though the mediastinum is well protected from injuries being guarded by the vertebrae behind, sternum in front and the lungs acting as buffers on either side, it is not uncommon for a severe crushing injury of the chest to cause damage. The fractured ends of the ribs may cause damage to mediastinal structures; injury to one of the intercostal vessels may lead to the formation of mediastinal haematoma; a crushing injury may cause rupture of the trachea or a main bronchus and may be responsible for the production of massive mediastinal emphysema.

The causes of crushing injury are similar to those producing injuries of the lung. The trachea, oesophagus and the great vessels may be torn and give rise to a massive haemorrhage and cause severe pressure, pneumothorax and emphysema. Penetrating wounds of the chest such as stabs by daggers, or knives and gunshot wounds may produce very serious damage to the mediastinal structures such as large vessels, trachea, bronchus, etc. Penetrating injuries are followed by the alarming symptoms of massive haemothorax, haemo-pneumothorax, mediastinal emphysema and, if the thoracic duct is involved, chylothorax. Acute mediastinitis of a fulminating type may follow these accidents if the patient survives. Injuries to the pulmonary vessels, ascending aorta, superior vena cava, innominate veins, and inferior vena cava have been recorded. As a rule, wounds of the great veins of the mediastinum are not immediately fatal. They succumb later on as a result of extensive thrombosis or infection following it, while wounds of the arteries prove immediately fatal from loss of blood. I had a case of a Pathan, stabbed in the 8th intercostal space, with an external wound at least 2 to 2½ inches long, and bleeding profusely. An immediate exploratory thoracotomy was performed. The pleural cavity contained a large haemothorax; this was removed by suction and swabbing. The lower lobe of the lung was cut right through except at the upper attachment to the bronchus and there was a tear on the diaphragm near the right pulmonary ligament with a small nick in the inferior vena cava. Lobectomy of the damaged inferior lobe of the lung was performed and one suture applied to the diaphragm. Oozing from the inferior vena cava was controlled by swab pressure and further checked by applying a muscle graft and maintaining a persistent but gentle pressure for about five minutes. The bleeding stopped and the wound was closed in the usual way; the patient made an uneventful recovery.

Injuries of the large vessels require immediate operation. A number of successful surgical operations on the great vessels of the mediastinum have been recorded. Relief of mediastinal emphysema by incision in the jugulum or by dealing with the cause has already been mentioned. Penetrating wound of the esophagus is an extremely rare condition and require

prompt treatment with drainage, otherwise it will lead to infection of the mediastinum. Injury to the thoracic duct may occur in penetrating as well as in non-penetrating injuries of the chest, though the incidence of this injury in non-penetrating wounds is greater than in cases of penetrating ones. Bullet wounds are often the cause of injury to the thoracic duct. A number of cases have been recorded in the literature of injuries of the thoracic duct. The clinical picture following injury of the thoracic duct is one of profound shock. After a latent period varying from 2 to 3 days the chest presents the signs and symptoms of pleural effusion which on aspiration proves to be a chyle. The striking feature of chylothorax is the rapid reaccumulation of large amounts of fluid even after repeated aspirations. Immediate cardiac failure may occur as a result of pressure caused by a large collection of fluid in the thorax or delayed death may occur after several weeks from inanition and asthenia. The treatment is very unsatisfactory and consists in aspiration of fluid to relieve the pressure and the adoption of sustaining measures. Intravenous injection of the aspirated chyle has also been suggested but found of to be of no great value.

Mediastinal emphysema and traumatic asphyxia are interesting conditions occurring in the mediastinum and have already been described under the heading of "Injuries of the Lungs and Pleura."

#### THORACO-ABDOMINAL INJURIES

The association of injuries of the abdominal viscera with thoracic injuries is of very frequent occurrence in non-penetrating crushing injuries as well as in the penetrating injuries usually of the lower thorax. Out of a series of 307 cases, there were 28 cases of wounds of the diaphragm involving liver, spleen, or stomach. The incidence of abdominal injuries in penetrating stabs was greater on the left side than on the right. Herniation of omentum, stomach and spleen was found on the left side. There were 7 cases of stabs in the liver, 3 in the spleen, 6 in the stomach and 12 cases of wounds of the diaphragm. Out of these 12, in 8 cases there was herniation of omentum only. Rupture of the diaphragm from non-penetrating injuries due to indirect violence is more common on the left than on the right as the liver prevents the transmission of a sudden strain. A bursting tear of the diaphragm may be associated with injuries of the abdominal viscera in automobile accidents. Crushing injuries of the thorax may tear the diaphragm by fractured ends of ribs acting as direct traumatic agents. I have not collected statistics of non-penetrating injuries involving the thoraco-abdominal regions but it is believed that the incidence of such accidents has increased, owing to more frequent automobile and aeroplane crashes. In war injuries penetrating types of wounds play a greater role in thoraco-abdominal injuries. Though penetrating injuries are commonly found on one side only bilateral

ones are sometimes present. In both these types of injuries, shock and pain, and other clinical syndromes like pneumo-thorax, haemo-thorax, etc. occur. In almost all the cases recorded above there was haemorrhage either from the lung, liver, stomach, the spleen or the diaphragm. Fast pulse and dyspnoea, resulting either from pneumothorax, haemothorax or other conditions associated with other intra-thoracic lesions may be present. Pain referred to the epigastrium, resistance of upper abdominal wall, tenderness, sometimes rigidity and referred pain to the shoulder are pathognomonic symptoms indicative of injuries of the abdominal viscera. Later, other symptoms may develop due to herniation with consequent disturbances in the function of the gastro-intestinal tract and to cardio-respiratory derangements. Symptoms are not acute in cases of simple herniation of the omentum through a tear of the diaphragm provided there are no other lesions in the thorax or the abdomen. In some cases there may be no symptoms except slight discomfort in the chest and the patient only comes when there are acute symptoms of strangulation.

The diagnosis of a traumatic diaphragmatic hernia is an extremely difficult problem particularly when only the diaphragm is involved. If the possibility of herniation in thoracic injury specially in penetrating wounds of the lower part of the thorax is borne in mind, there will be less chances of overlooking the condition. X-ray examination in doubtful cases may clinch the diagnosis by demonstrating abdominal viscera in the thoracic cavity. Herniation of the abdominal viscera into the thoracic cavity, produces a sense of distension in the stomach or colon. Displacement of the heart accompanied by some degree of dyspnoea will call for careful examination of the patient. Strangulation of the stomach or a part of the colon or occasionally of the small bowel is of great gravity and prompt measures will have to be undertaken immediately. As regards the treatment of traumatic rupture of the diaphragm, early operation is to be contemplated; once the shock is over. Other associated injuries will also require attention. Surgical repair of the hernia may be done by thoracotomy or laparotomy. Sometimes a combination of these routes may be necessary if abdominal injuries are suspected side by side with the thoracic injury. Careful and close exploration of the herniated structures is an essential step of the operation in order to find any tear in the viscus. Herniated viscus after repair if necessary is gently returned to the abdomen and the sub-diaphragmatic region is properly explored, for any damage to other structures. Crushing of the phrenic nerve in the thorax facilitates the operative manipulations. The diaphragmatic tear is closed with interrupted catgut sutures.

Besides herniation a tear in the liver or the spleen may be present; the principal symptoms will be haemorrhage in the peritoneum, pain, localized tenderness and rigidity of the abdomen; these will be associated with symptoms of involvement of thoracic viscera such as haemothorax,

pneumothorax, etc. Diagnosis is often difficult as lower thoracic injuries without involvement of abdominal viscera often produces rigidity; this, however, is of an intermittent type and is unilateral. Besides rigidity the sickness and vomiting also may occur in thoracic injury, but are more frequent in abdominal injuries. Injury to the diaphragm causes the thoracic type of respiration with a catch at the end of inspiration. At a later stage, pain referred to the shoulder region or to the clavicle, occurs.

The treatment of these complicated injuries naturally consists in the management of shock, and control of haemorrhage. Sucking wounds of the thorax will have to be immediately attended to and the liver tear may be sutured through the diaphragm if possible. Wounds of the kidney may be explored through the usual posterior incision. In injuries of a hollow viscus in the abdomen, the abdominal approach is indicated. It has been reported that a number of spleens have been removed through the thoracic route but I think that the abdominal route is most desirable for removal of the spleen and to attend to other associated injuries. Sometimes the abdomen and the thorax have been separately opened to deal with these conditions. Out of the 28 cases of the abdominal injuries in association with the thoracic injuries among the series of 307 cases previously mentioned, there were 10 deaths, the mortality rate being 36 per cent. The high mortality rate is attributed to haemorrhage, prolonged operation and resulting shock, and part of it is due to missed injuries, either of the abdomen or of the thorax. In the Bombay City riot of 1932 total no. of patients who attended the out-door and indoor at the J. J. Hospital were 677—out of this 292 were inpatients and 73 were cases of chest wounds. 17 of these died giving a mortality rate of 20 per cent. 13 of these 73 were operated on (exploration of the thorax) with a recovery in 50 per cent of cases. 56 abdominal injuries were admitted and 28 died out of these cases, the mortality rate being 50 per cent. Thoraco-abdominal injuries as such carry a high mortality because of the multiplicity of their nature and non-recognition of their presence. It has been observed that wounds associated with injury to the hollow viscera carry a higher rate of mortality than those with involvement of the solid viscera. The mortality figures in the great world war in some hospitals amounted to over 60 per cent. in thoraco-abdominal wounds while in civil practice these wounds carry a mortality rate of 25 to 30 per cent, because of the lesser involvement of the organs in civil wounds and their comparative freedom from sepsis.

My thanks are due to Mr. S. R. Moolgavkar and to the late Dr. P. T. Patel for their inspiration and guidance, to Drs. E. J. Ramdas and S. G. Talwalkar, anaesthetists to the J. J. Hospital, Drs. S. P. Mehta and K. V. Kulkarni for valuable help in collecting statistics and Lt.-Col. J. M. Shah, I.M.S., for permission to use the hospital records.

## DISCUSSION

Dr. M. G. Kini (Madras) reported a case of chest injury of a man who was stabbed in the back in the year 1926 in Calcutta during the communal riots. He was taken to the hospital where the wound was sutured but no attempt was made for the removal of the broken blade of the knife. The patient had kept good health until two years before admission when he began to develop a cough with small bouts of haemoptysis which gradually weakened him and the last haemoptysis was so severe that he got himself admitted to the hospital. X-ray showed the broken blade of the knife in the chest.



Fig. 1. Lateral view.



Fig. 2. A. P. View.

To control the haemoptysis pneumothorax was done in the Tuberculosis department. Later on an exploration was done after removing the second, third, fourth and fifth ribs. On opening the pleural cavity a glairy looking fibrinous material was removed and on exploration the lung was found to be collapsed but it was difficult to locate the blade. So the thoracic cavity was closed with a drain. The patient had a stormy recovery. At the time of speaking, Dr. Kini said that he was not sure whether the patient was alive or dead. He asked one of his colleagues who had come from Waltair whether the man was alive or if any further attempt was made for the removal of the blade.

Dr. Kini reported also a case of gun shot injury due to a rifle bullet which accidentally went off while the patient was on guard duty. The entrance wound which was small with charring was just below the middle of the left clavicle and had caused comminuted fracture of the clavicle. The exit wound was just above the spine of the scapula with lacerated edges. The patient was shocked and due to haemothorax respiration was embarrassed. On admission he was given plasma, the wound was covered with a thick pad to prevent suction of air. He was explored after recovery from the shock. The two wounds were connected across the top of the shoulder and all lacerated muscles which were suspicious were cut away and a complete debridement was done. It appeared as if the bullet had, after striking the middle of the clavicle, traversed behind the scalene muscles in front of the first rib in between the fascia and the apex of



the lung. The brachial plexus was found covered with a lot of clot. It was thought not desirable to prolong the operation to explore the plexus. By some luck, the sub-clavian artery had escaped injury. All the suspicious and devitalised portions of the muscles were cut away and sutured wherever it was possible and then the wound was freely plastered with Streptocide and drained in the most dependent part and the limb was put in abduction at right angles with the shoulder in external rotation and the elbow at right angles and supported by plaster of paris jacket and abduction splint. The patient made an uneventful recovery and before discharge from the hospital at the end of two months, the nerve recovery was found to be slow but there were signs of recovery of the common flexors and common extensors of the fingers and short muscles as shown by recovery of movements at metacarpo-phalangeal and inter-phalangeal joints.

**Dr. R. N. Cooper (Bombay).** As far as possible a conservative attitude was followed because the type of cases encountered at the K. E. M. Hospital were of such nature. Repeated aspirations were employed in cases of haemothorax. Open drainage was not encouraged routinely in all cases of thoracic injuries. The value of a blood-bank and plasma-storage was emphasised. A case was reported where about four transfusions were done pre-operatively in a practically moribund case before a surgical exploration could be undertaken. Two further blood transfusions were done post-operatively. The quantity injected each time was between 300 c.c. and 350 c.c.

**Dr. R. Mahadevan (Vizagapatam).** My remarks are from observations derived from some cases of injuries of the chest that were under my care.

**Case 1.**—A Naval Rating walked up to the wards with an injury to the chest wall of 4 hours' duration. It was caused by some splinters from a bomb which crashed near the deck where he was working. The patient was inclined to think that there was nothing serious with him. He said he came just because his doctor insisted on his reporting to hospital. Examination showed a small lacerated wound in the left 7th interspace in the posterior axillary line. However, a large area around looked swollen and oedematous. His temperature was  $100^{\circ}$ , and pulse rate 110. The wound was immediately excised and the margins enlarged for exploration. Very extensive laceration of all the muscles of the chest wall, right up to the sternum in front and to the outer margin of the erector-spinae muscles behind was found. In fact, the muscles under the scapula were practically pulped. Wide excision had to be performed to avoid the danger of gas gangrene, and the area of muscles excised was the size of both the palms put together. Yet there was no injury to the ribs, scapula or intra-thoracic structures and this was a very striking feature. Small metal fragments found during the operation were removed. The wound was dusted with sulphonamide powder and left wide open loosely packed with flavine gauze. He was evacuated from the hospital 8 days later in good health. The following points are worthy of note in this case:—(1) The wound, though very extensive, had little effect on the patient, who himself thought that there was practically nothing the matter with him. (2) The ribs, scapula and intra-thoracic structures escaped injury, in spite of the extensive pulping of the muscles. (3) Had the wound been considered as one that could be safely watched with some dressings and administration of sulphonamides, gas gangrene would almost surely have supervened.

**Case 2.**—Refers to a Sepoy, who, in a practice demonstration purporting to show the methods of taking shelter in shallow trenches in active warfare, hunched his back up, hiding his head below like the proverbial ostrich. The consequence was, he was thereby accidentally shot through the back. When he was brought to the hospital he was exsanguinated and intensely shocked. Before he could be operated on, he had to be given a blood transfusion. A wound involving extensively the muscles of the back was then excised, and a small tear of the pleura found in the depths of the wound was sutured.

Several more blood transfusions had to be given before he rallied. In this particular case, though the pleural cavity was opened up, it was not a factor of much importance. What he required and what saved his life was the repeated blood transfusions that overcame the effect of blood loss and shock.

Case 3.—Fig. 1 shows a case of simple fracture of the 4th rib with an unsuspected pneumothorax which shows the importance of routine skiagrams in these conditions. The presence of surgical emphysema is also well shown in the skiagram.

Case 4.—Refers to an adult who had multiple stab wounds of 3 hours' duration, one of which penetrated the left pleural space. The tear in the pleura admitted a finger easily and the lung was collapsed. There was no haemothorax or foreign body. With positive pressure anaesthesia the lung expanded. The wounds were all attended to on ordinary surgical principles, but I did not feel quite sure if the pleural cavity should be drained or not. The external wound was very septic and was excised. If the pleural cavity should be drained at all, commonsense dictated it should be drained through the most dependent part by a separate clean incision. However, I thought it to be too drastic a measure at the time and adopted a compromise, viz., suturing the tear around a corrugated drain that led into the pleural cavity, and leaving open the wound in the parietes loosely packed with flavine gauze. The whole thing was well covered with strappings. The course of events proved however that the compromise was bad. It was difficult to keep the wound air tight and the lung repeatedly collapsed. This occurred even as late as the 8th day. The patient was in distress, curiously and mainly complaining of dysphagia. On introducing a needle into the pleural cavity some air escaped and the patient had considerable immediate relief. This procedure had to be adopted more than once. Thus, on the 4th morning after the operation, when his discomfort increased the intra-pleural pressure was plus 20 cms. water. 400 c.c. of air was drawn off when the pressure fell down to -4 c.m. water and the patient again felt comfortable. Yet, the subsequent course was not smooth. The diagrams attached bring out the points. Massive collapse of the lung occurred (Fig. 2). Later, a pleural effusion also developed (Fig. 3) which fortunately did not get infected. No aspiration was done either, as the patient developed no symptoms. He ultimately recovered. Skiagrams (Fig. 4) taken 11 months later shows the almost normal condition, except for a slight peaking of the diaphragm, the only evidence of old inflammation and adhesion. Here, one important point is worthy of being drawn particular attention to. The skiagram (Fig. 3) shows apparently only a small fluid collection, but a fluid collection sufficient to obliterate the phrenicocostal sinus and reach up to the horizontal level of the dome of the diaphragm will amount at least to 10 ounces.

The inferences from the above case are as follows:—

It was quite wrong to have drained the pleural cavity through the original wound by a corrugated drain. It was not possible to keep the wound air tight and so the lung repeatedly collapsed. I now think that the tear in the pleura must have been sutured completely and the wound in the parietes packed with gauze and strapped air-tight. If the course of events warranted it, the pleural cavity could have been drained later. Alternatively, at the primary operation itself the pleural cavity must have been drained through a separate wound, excising portion of a rib at the most dependant part and arranging for under-water drainage. This perhaps would have been the better procedure. If the chances of infection seemed remote an intercostal drainage at the most dependant part would perhaps have equally well served the needs of the case. That the patient mentioned above, ultimately did well even though the principles outlined were not adhered to, is no argument in favour of the treatment adopted in the particular case. For, it was quite on the cards that the effusion might have got infected, with all the



Fig. 1. Fracture 4th rib (case 3) (arrow mark) with an unsuspected pneumothorax (p) and obvious surgical emphysema (e).

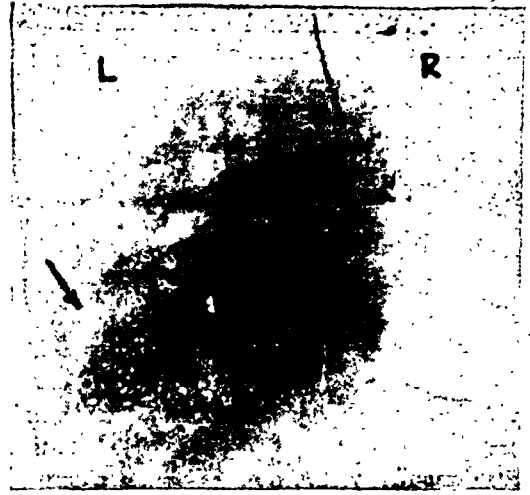


Fig. 2. Skiagram of chest of case 4, eleven days after injury, showing collapsed of left lung. Left dome of diaphragm is pulled up and the heart is pulled over to the left. Note also the small pocket of air in the pleural cavity (arrow mark), a remnant of the pneumothorax that had occurred.



Fig. 3. Skiagram of same case as fig. 2. (case 4) 24 days after injury. Note the fluid collection in left phrenico-costal space.



Fig. 4. Same case as fig. 3 (case 4) showing condition a year later which is practically normal except for the slight peaking of the diaphragm (arrow mark).

dangers of an empyema. A peculiar feature noted in this case was, that every time the lung collapsed, the patient complained of and worried about difficulty in swallowing. Possibly the positive pressure not only caused shifting of the mediastinum but also produced in its wake kinking of the esophagus. He of course had dyspnoea, but this did not seem to upset him so much as the dysphagia.

Case 5—Refers to an adult who had a gun shot injury of the right chest penetrating the pleural cavity. Debridement of the wound, suture of a tear in the pleura and blood transfusion led to recovery, but his temperature chart showed how aspiration of some small quantities of blood every time resulted in bringing down a swinging temperature to near normal. After the third aspiration the temperature kept normal. Though the patient was running a temperature in between these aspirations, culture of the aspirated blood proved sterile every time. This shows that a small quantity of blood in the pleura, even in the absence of infection, can account for persistent and even high temperature. It must be said however that the patient was on M. & B. 693 tablets all the time and how far the beneficial effect was due to it and how far it was due to the aspirations it is difficult to say.

Case 6—A man of 35 came with a discharging sinus in the left 1st inter-costal space just below the middle of the clavicle. Eleven months previously he sustained a stab wound and within a few hours of the accident the wound was attended to and sutured up in a local hospital. A fluctuant swelling occurred over the sutured area. This was incised on the 13th day when dark blood and some pus escaped. He was in the hospital for 2½ months but the wound did not heal and he was discharged with a persisting sinus. He was attending thereafter as an out-patient. Pus used to get pent up now and again resulting in high fever, breathlessness, pain in sternal region and anorexia. He had no cough and the loss of weight was slight. This state of affairs recurred often and eleven months after the original injury he reported to this hospital. Skiagrams of the chest taken before and after lipiodol introduced through the sinus brings out clearly the existence of a big empyema (Figs. 5 to 7). This was drained at the most dependant part and a large drainage tube was introduced. He rapidly got better. The interesting thing was that the pus on staining showed in addition to streptococci, diplococci and micrococci, tubercle bacilli also. Very likely he had a latent tuberculous focus, which flared up consequent on his resistance being lowered by the chronic empyema, or more likely a latent tuberculous focus had burst into the empyema cavity. He had no cough. It is worth pointing out here that a chronic non-tuberculous empyema may become tuberculous in the course of time. This can be found out only by periodical examination of the pus and biopsy of the thick wall of the empyema cavity.

Case 7 is that of an old man who fell from a height and sustained multiple injuries. He had fractures of several ribs on both sides (Fig. 8), Colles's fracture and fracture of the humerus. He was intensely shocked and dyspnoeic and had surgical emphysema. Air entry on the left side was poor. A needle was introduced under local anaesthesia into the pleural cavity but no air escaped. It was connected to a manometer, which showed a negative pressure and there was oscillation with respiratory movements. The fractured ribs and other fractured areas were infiltrated with 2% novocaine and the patient became immediately comfortable. Next day the patient had increasing dyspnoea and rapid pulse (respiration 38, and pulse rate 142). A needle now introduced into the left chest showed plus 4 cms. water pressure, 300 ccs. of air was drawn and the needle was left in place connected to under-water drainage. The needle was removed when he got better, but the process had to be repeated on the 3rd, 4th and 5th days also, leaving the needle in place, hours at a time. He was very ill for several days and only on the 14th day did the respiratory and pulse rate come down to near normal. Ultimately he recovered.

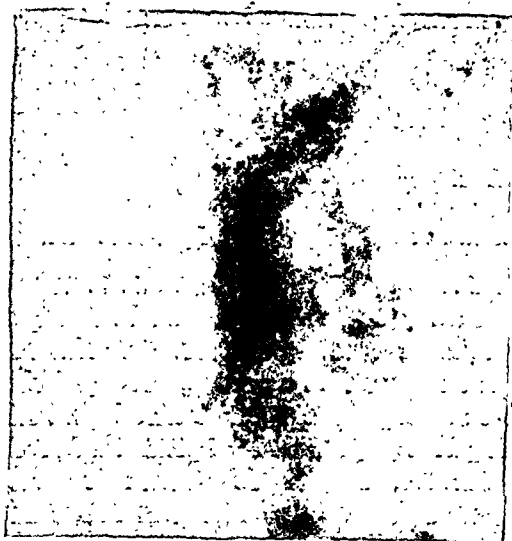


Fig. 5. Plain X-ray of chest of case 6, eleven months after a stab wound of left 1st interspace,

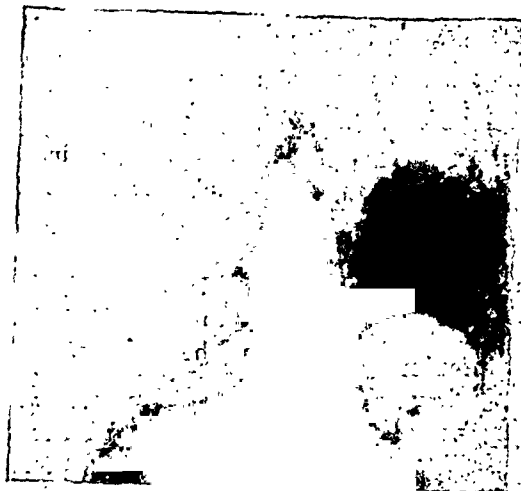


Fig. 6. Same case as Fig. 5 after introducing lipiodol through the sinus in the 1st interspace. Note the lipiodol in the depths of a big empyema cavity.

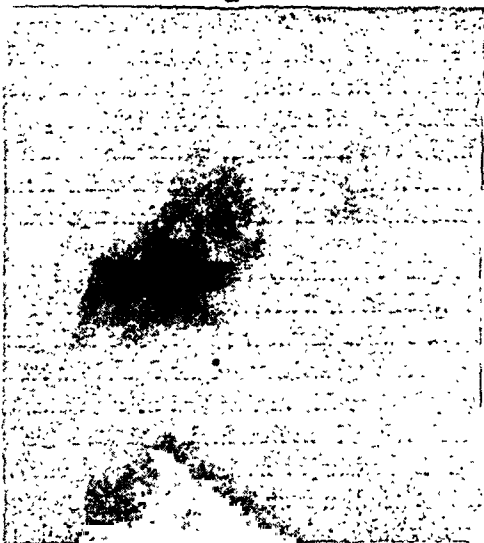


Fig. 7. Same case as Fig. 6 lateral view. The pus in this case contained tubercle bacilli and various secondary organisms.



Fig. 8. Multiple fractures of several ribs both sides (arrow mark), fracture left humerus, pneumothorax on left side with collapse of lung (L) and surgical emphysema (e).

The dramatic relief the patient had soon after injecting novocaine into the areas of fractured ribs is worthy of note. The treatment of fractured ribs by novocaine injection deserves special mention. The basis of this treatment has been explained as follows: (Neal Smith, 1912). The pain in fractured ribs is not due to the rubbing together of the fractured ends, for if this were so the pain must be at its maximum at the height of expiration. This however is not the case. It is well known, that the pain increases during the inspiratory phase and the inspiration suddenly stops with a catch. This is due to spasm of the intercostal muscles at the fractured area. This spasm is abolished by novocaine injection at the fractured area or what amounts to the same, by blocking the related intercostal nerves. I have tried both the methods in a few cases and in all of them dramatic relief resulted. The effect lasts not merely for a few hours, but for several days, so that it practically amounts to a permanent cure. In some cases, however, the patient did complain of pain on the second or third day and a second novocaine injection was required. In the case referred to above, after the 2nd injection he was perfectly free from discomfort so far as the fractured ribs were concerned. The time honoured treatment of strapping the chest wall for fractured ribs has several disadvantages. (1) Even with proper strapping the relief is not always complete. (2) The strappings often get loose and cease to serve the object intended. (3) If firmly strapped, especially in the elderly, the respiratory excursions and coughing may be so interfered with that the patient is unable to cough up the secretions. Inflammatory complications of the lung may therefore arise.

It seems logical, that proctocaine injection may give a more lasting effect than novocaine, and I have injected proctocaine in some cases. However, the cases so treated are too few to come to any definite conclusions. It has been suggested by some that alcohol may be injected. This should never be done. After alcohol injection, neuritis of intercostal nerves may result, a condition much worse than the original malady itself.

In conclusion it may be pointed out that:—

- (1) A very serious injury may underly an apparently trivial injury to the chest wall.
- (2) Blood transfusion has a very definite life saving value in selected cases.
- (3) A routine skiagram is required in all but the most trivial injuries.
- (4) If drainage of the pleural cavity is required, it is better drained through a separate incision in a dependant part of the pleural cavity and not through the main wound.
- (5) A small haemothorax, though sterile may give rise to persistent swinging temperature for a number of days.
- (6) A case is reported of a persistent discharging sinus after a stab wound and the underlying cause was a big empyema. The infection was mixed, in which tubercle bacilli also were found. The significance of the tuberculous infection in the case is discussed.
- (7) Treatment of fractured ribs by novocaine injection at the fractured areas or of the related intercostal nerves appears to be the best. Strapping the chest wall probably does more harm than good and is better abandoned. In fact the advantages of the former are so great and the discomforts of the latter so much that I feel quite justified in being dogmatic and say that treatment of uncomplicated fractures of the ribs must be only by novocaine injections of fractured areas.

My thanks are due to Major F. A. B. Sheppard, O.B.E., I.M.S., Superintendent, King George Hospital, for permission to publish these cases; to Dr. K. G. Krishnaswami for utilising his case (case No. 5); and to Dr. G. V. Benjamin the Radiologist for reprints of skiagrams.

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**Dr. S. B. Gadgil (Bombay).** Dr. Patel in his paper has not made clear some of the symptoms and clinical signs as regards stab wounds of the heart. After stab wounds of the heart patient is collapsed for a time, his pulse is weak he suffers from shock. He then recovers; he may carry on his work, he may climb up a couple of stairs of a building and then drop down dead. His symptoms resemble those of a patient suffering from extradural haemorrhage after an injury. A period of unconsciousness followed by recovery to a certain extent then again unconsciousness. After heart wounds there is no bleeding for a time due to shock. About 100 to 200 c.c. of blood must collect in the pericardium before signs of tamponade of heart become manifest. The patient may run or may continue to fight during this period. Tamponade causes cerebral anaemia due to diminished arterial pressure and leads to coma; venous pressure is increased from 3 to 4 c.c. of water (as shown by a water monometer) to 13 to 14 c.c. This will account for his temporary excitability. There is pallid cynosis of lips and tongue and a probe put in the wound will pulsate.

**Dr. A. V. Baliga (Bombay)** gave some figures regarding the incidence, varieties and results of Thoracic injuries admitted to the wards of the K. E. M. Hospital, Parel.

**Dr. C. P. V. Menon (Madras)** stressed the importance of first aid measures particularly with regard to sucking thoracic wounds. He pointed out the importance of accurately localising foreign bodies and mentioned a case in which the absence of such localisation very nearly resulted in an unnecessary thoracotomy. He referred to two cases of abdomino-thoracic injuries in one of which a hernia through the diaphragm was associated with wounds of the spleen and left kidney; these latter were not noted at the time of the operation and led to a fatal termination.

**Dr. G. D. Kapur (Lahore).** My remarks apply only to injuries of the chest as met with in Civil practice and I would like to lay emphasis on two points: (1) That with the exception of sucking wounds which are to be immediately dealt with most chest-injuries, when watched will eventually develop into definite pathological entities, demanding a definite line of treatment. For example, haematoma indicating aspiration, empyema indicating drainage and so on. Exploration or active surgical interference as is sometimes indicated in abdominal injuries has little place in chest injuries. Conservatism gives better results than radical surgery. (2) The Surgeon is handicapped in the elicitation and interpretation of physical signs in the chest. The combination of high technical skill with highly developed clinical acumen is not very common. To do justice then, he must have the assistance of a physician to properly evaluate physical signs. To illustrate this difficulty, I would quote a case of a penetrating wound of the left lower chest inflicted with a spear. The patient was dyspnoic and cyanotic. The heart was displaced to the right and the left chest was hyper-resonant on percussion and curious sounds thought to be amphoric were auscultated. I ascribed the condition to tension pneumothorax, and put in a needle to allow the excessive pressure to diminish. The distress however persisted and the patient eventually died. The death was put down to tension pneumothorax. As the case was a police case a postmortem had to be done and it was dis-

covered that the spear after traversing the pleural cavity had penetrated the tendinous dome of the left diaphragm. The stomach had herniated through into the left pleural cavity completely collapsing the left lung and pushing the heart to the contralateral side.

Dr. Patel briefly replied to the points raised in the discussion.

The President in concluding the discussion paid a tribute to the exhaustive manner in which the opener had dealt with the subject and to the interest evinced in the discussion which followed.



# A CASE OF FOREIGN BODY IN THE ESOPHAGUS

BY

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Mir Zaman, Mohammaden, male, aged about 30 years, was admitted in the Civil Hospital, Abbottabad, on the 5th April 1944, with difficulty in swallowing and constant dull aching pain at the region of the xiphisternum. He gave a history of swallowing a dental plate about two years back. X-ray plate showed impaction of the plate at the cardiac end of the esophagus at the level of the cartilage between X and XI Dorsal Vertebrae. On screening after barium meal the esophagus showed slight dilatation and retroperistalsis and after a few moments the meal trickled down into the stomach.

The patient had applied for treatment at the local Hospitals in the neighbourhood and had even been to Bombay. He was refused operation and was passing his days in agony.

Being a general surgeon and not equipped with special instruments like the esophagoscope, etc. I thought it should be possible to remove the plate through the stomach, if necessary, after breaking the plate with a strong clamp.

After explaining to the patient all the pros and cons of the operation, to which he easily submitted, the operation was decided upon.



Fig. 1. X-Ray of the foreign body.



Fig. 2. Photograph of plate removed.

Transverse laparotomy was done on the 17th April, 1944, along the trans-pyloric plane. It was possible to locate the plate near the cardiac end of the esophagus by passing the finger upwards along the lesser curvature of the stomach. The stomach was opened as high as possible on its anterior

surface and a clamp was passed upwards towards the cardiac end, being guided by the left hand localising the plate from outside the stomach near the diaphragmatic opening of the esophagus. The manoeuvre was not so easy as it looked. After a few minutes' struggle it was possible to get hold of the plate with the clamp and, with a slight pull, to remove it. The stomach was closed by double purse string catgut stitches and the abdomen closed in layers.

The patient made an uneventful recovery and stitches were removed on the 11th day, i.e., on the 28th April, 1944. The patient could now swallow solid food without any difficulty.

The case is interesting on account of the long history and the method of treatment adopted.

# THE SINGLE CARTILAGINOUS EXOSTOSIS AND THE INDICATIONS FOR SURGICAL INTERFERENCE

BY

DOZENT DR. GEORGE POLITZER

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The simultaneous occurrence of multiple cartilaginous exostosis and enchondromata has been observed in many cases during the last decades. After the discovery of the X-Rays *Kienboeck* returned again and again to this interesting chapter of bone and joint disease. The stress laid on the multiplicity of the cartilaginous exostosis was instrumental in forgetting that in a great number of cases the bone changes are confined to one single area. These single cartilaginous exostosis show a rather typical localisation: They start from the distal metaphysis of the femur one or two inches above the epiphyseal scar. They mostly originate from the lateral side of the shaft and only occasionally as in Fig. 1 of this paper from its medial surface. We find these changes far more often than generally expected as they usually do not cause any clinical symptoms, but are detected only during an X-Ray examination performed for some other reasons as, for instance, traumatic injury to this area or rheumatic pains in the knee joint. Knowledge about some important features of these exostosis is important for the surgeon too, as there are strict indications for surgical interference, if one or the other complication occurs.

The typical cartilaginous exostosis consists of a conical bone stick growing out of the metaphysis of the bone in a proximal direction. The end of this stick carries a globe shaped cartilaginous body, which, itself, is crowned by loose connective tissue, in which occasionally a typical bursa may develop. Fig. 1 shows a cartilaginous exostosis of the type just described. The cartilaginous extremity is not visible as cartilage and muscular and fibrous tissue surrounding it offer the same density to the penetrating X-Rays, so that the limits between the above tissues are not marked by any contrast. In the histological picture of a section through such a cartilaginous exostosis (Fig. 2) the spongy bone (S.B.) is covered by a cap of cartilage (C.) whose structure is rather irregular. These cartilages forming the extremity of the exostosis are subject to metaplastic changes in their structure. Often the whole cartilage is substituted by bone (but for a microscopical layer on its utmost extremity). In this case the exostosis becomes visible in the X-Ray picture in full as for instance in Fig. 3. In other cases parts of the cartilage degenerate, a process which leads to incrustation of the decaying material

As already said before the cartilaginous exostosis are discovered mostly by mere accident, the best proof, that they are usually not causing



Fig. 3. Cartilaginous exostosis with ossified extremity



Fig. 4. Cartilaginous exostosis whose extremity consists partly of cartilage, partly of bone and partly of calcified areas without structure corresponding to lime deposits in necrotic cartilage

any kind of clinical symptoms. The main reason, why they are considered as no object for surgical interference is, on the one hand, the absence of any troubles to the patient, on the other, the well known fact that they show practically no inclination towards malignant degeneration. It is also rather probable that the surgeons, fed on the knowledge that the cartilaginous exostosis is part and parcel of a generalised disease of the skeleton, are reluctant to interfere in one area, when apparently so many others are bound to be affected in the same way now or later. It has been mentioned already above, that this assertion is not based on realities, as the cartilaginous exostosis is very often the malformation of a single area only and does not involve the skeleton as a whole. The following paragraphs shall be devoted to the three main indications for surgical interference, out of which the first is self-explanatory, but the second and third are based on observations which are not common knowledge so far.

No. 1. In some cases the cartilaginous exostosis stretches and protrudes the surrounding tissue to an thin, smooth

with lime salts. The structure of these calcified islands of the bone is dense and homogenous. Thus the extremity of an exostosis may consist of cartilage, bone and secondarily calcified necrotic cartilage. This leads to the

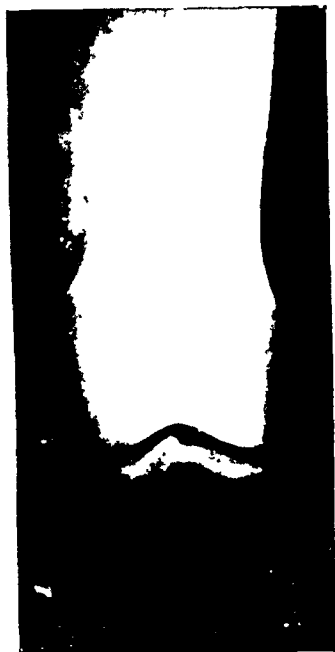


Fig. 1. Cartilaginous exostosis with cartilaginous extremity thus not discernible in the X-Ray picture



Fig. 2. Microscopical section through the extremity of a cartilaginous exostosis : C. Cartilage, S. B. spongy bone

variety of structures observed in cases like Fig. 4, in which the dense homogenous part corresponds to necrotic and encrusted cartilage, the trabecular structure to bone and the "defects" to cartilage, as, for the above reasons, cartilage cannot be distinguished from other soft tissues and appears thus as a defect in lime containing surroundings. In adults the mushroom-shaped exostosis is the usual manifestation of this malformation. But in the growing individual the form is often that of a half globe as shown in Fig. 6, whose detailed description will follow later on. The cartilaginous exostosis is occasionally found in other parts of the human body too, but wherever it may occur one rule is followed with greatest meticulousness—the exostosis grows always in the direction towards the middle of the shaft; thus an exostosis of the distal metaphysis will grow proximad, while one of the proximal one will be directed distad,

As already said before the cartilaginous exostosis are discovered mostly by mere accident, the best proof, that they are usually not causing

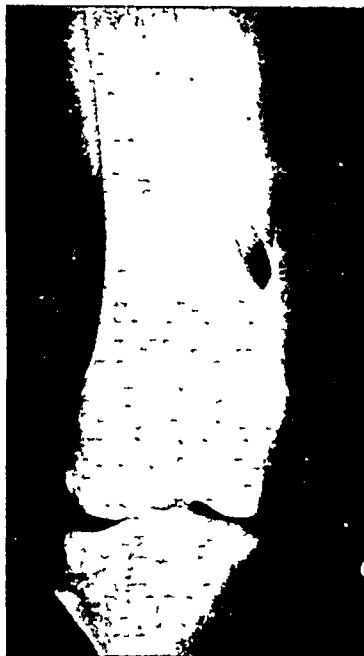


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No. 1. In some cases the cartilaginous exostosis stretches and protrudes the surrounding tissue to an extent that the skin becomes thin, smooth

# CONGENITAL DIVERTICULUM OF THE BLADDER

BY

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Diverticula of the bladder may be of two types, (1) Congenital and (2) Acquired.

Congenital diverticula are of rare occurrence and according to Swift Joly, the treatment of large vesical diverticula is one of the most difficult problems the Surgeon has to grapple with. Acquired diverticula are pouches of mucous membrane herniated through deficiencies in the muscular wall of the bladder in cases of lower urinary obstruction, and the treatment is that of the obstruction. It is said that congenital diverticula do not give rise to symptoms before middle age and the cystitis and obstruction which brings the patient for treatment at that stage is often associated with enlargement of the prostate.

In 14 cases reported by Swift Joly (1923), the youngest was 37, and the others between 50 and 72. Ogier Ward (1938) published a report of 53 cases and in this series the average age incidence was 57 years, the youngest being 15; 3 others between 30 and 40; and 10 between 40 and 50. Keynes and Morel's (1943) case was 25. In the case reported below the patient was 18 years old at the time of operation and had had symptoms for 6 years.

The complications that may occur are (1) Cystitis which leads to dense perivesical adhesions. (2) Obstruction due to pressure of a large inert sac on the ureters and the bladder neck. (3) Stone formation in the bladder and in the diverticulum. (4) New growth—papilloma or carcinoma at the neck of, or within the sac.

No set operation is suitable for all cases. The operations described are (1) Excision from without the bladder—often facilitated by pushing a finger within the sac. This was the method used in our case and is particularly suited for diverticula situated high up on the fundus, posteriorly or in relation to the urachus. (2) Splitting the bladder wall down to the orifice of the diverticulum—the incision encircles the orifice and the diverticulum is then removed. Swift Joly says this method is dangerous as the ureter is in close relation to the posterior wall of the sac and is liable to be injured. Ogier Ward, however, performed the majority of the operations by this method. (3) Intra vesical operations by invagination of the diverticulum into the bladder is only suitable for small diverticula, and the outer surface must be cleared of all adhesions before invagination. (4) Keynes and Morel did a purely extra vesical dissection, isolated the

diverticulum, removed it by incising at the neck and closed the opening in the bladder. An indwelling urethral catheter was used to drain the bladder.

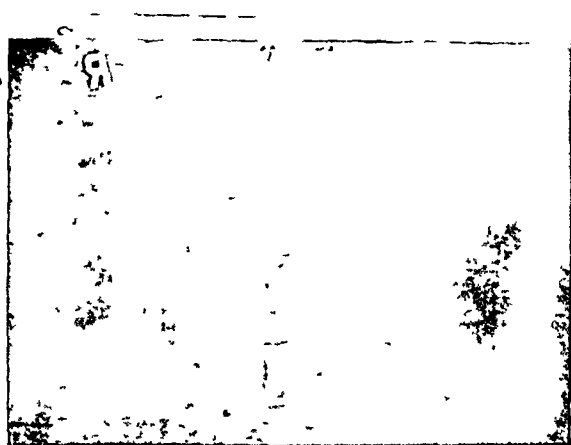


Fig. A. Intravenous Pyelogram : 15 Minutes

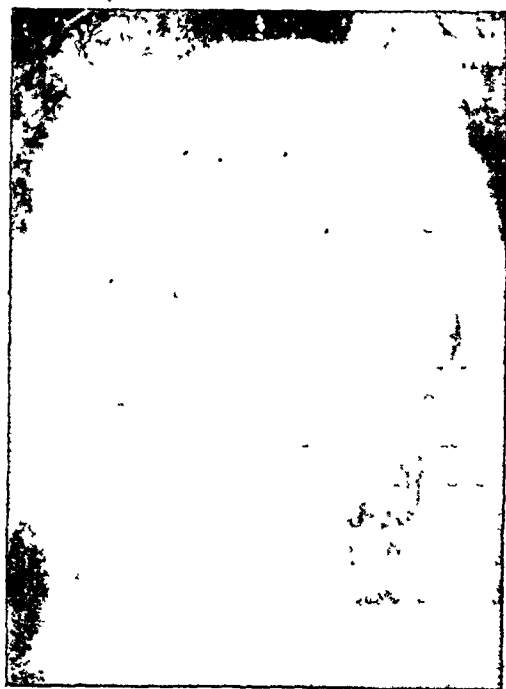


Fig. B. Cystogram

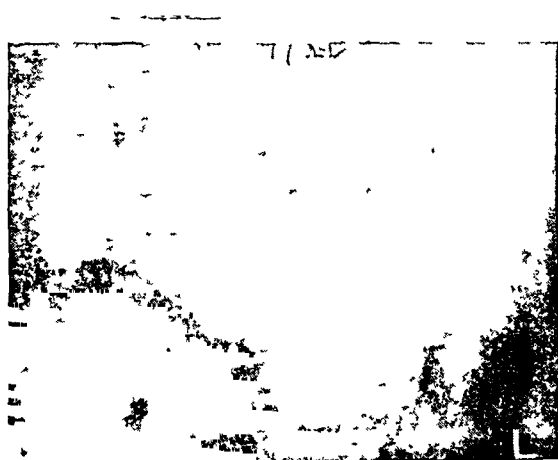


Fig. C. Intravenous Pyelogram : 17 Minutes

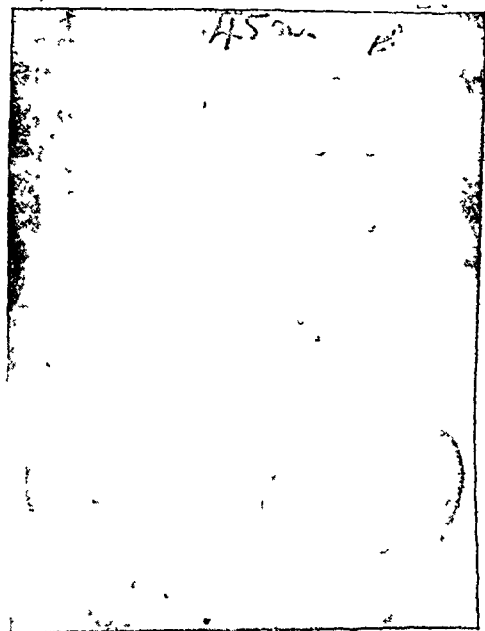


Fig. D. Intravenous Pyelogram : 45 Minutes

This method which does away with supra-pubic drainage reduces the period of invalidism and can be used in cases where cystitis is not severe.



Swift Joly condemns preliminary cystostomy as dangerous. The bladder contracts around the indwelling catheter and the opening of the diverticulum closes and the urine in the inert sac which is already infected forms a bag of pus which makes subsequent operation difficult and dangerous. If, however, the catheter is led into the diverticulum and drains it, the sac can be washed out and in our case certainly improved the cystitis. If the case is complicated by prostatic or urethral obstruction both conditions should be treated at the same sitting. When, however, the condition of the patient does not permit this, it is better to remove the diverticulum first and treat the obstruction later. The presence of a calculus in the bladder or in the sac is an indication for excision of the diverticulum. Even after the passage of a catheter, the diverticulum does not often empty completely and this urine which is often of considerable amount is termed by Joly, 'Concealed residual urine'; and can be demonstrated in cystograms taken after filling the bladder with an opaque medium and evacuating the contents by catheterisation. The presence of 'concealed residual urine' vitiates all tests of renal efficiency carried out on bladder urine and so, to get a correct estimate of renal function, the ureters must be catheterised or a blood urea estimation relied on.

### Case Report

M———, Hindu, male aged 18 years was admitted into the Government General Hospital, Madras on 28-3-1944.

His complaint was that for six years he had noticed that on micturition the bladder did not empty completely, and that he had to exert pressure over it with the hands to complete emptying. There was no difficulty in starting micturition nor did he have to strain to pass urine. He complained of fever with rigor coming on every 3 or 4 months for 3 or 4 days during the last two years.

*On Examination.*—The patient was a well-built adult, very anaemic. The bladder was distended up to the umbilicus. There was fullness and tenderness in the right loin but the kidney could not be palpated. The Spleen was enlarged five inches below the left costal margin. There was no abnormality of the nervous system.

*Investigations.*—(1) A rubber catheter was passed easily and on partially emptying the bladder, two lobes were felt—on either side of the middle line. The lobe to the left emptied first and after it was completely empty, the lobe to the right started emptying.

(2) *Urine.*—Turbid, foul smelling, alkaline, sp. gr. 1010, pus cells and bladder epithelium present.

*Culture.*—*B. coli* grown.

(3) *Blood Urea.*—28 mgs. %

(4) *Urea clearance.*—22.8%—19.2% Std. Clearance.

(5) *Skiagram of lumbar and sacral spine*—showed a bifid first sacral spine.

(6) *Intravenous pyelogram.*—Bilateral hydronephrosis and hydroureters—more marked on the right side, with delay of first appearance of dye to 45 minutes on the same side. (Fig. A.)

(7) *Cystogram*.—The bladder was filled with 10% Na.I. and was found to have a capacity of one pint. The antero-posterior skiagram showed two rounded shadows—one superimposed on the other. (Fig. B.)

On 11-5-1944 *Cysto-urethroscopy* was performed under Spinal anaesthesia (2 c.c. 7½% ethocaine). The bladder did not empty under Spinal anaesthesia thus ruling out the possibility of sympathetic over-activity causing retention. No urethral valves were visualised. The bladder mucosa showed cystitis. The left ureteral orifice was much dilated. The right ureteral orifice could not be visualised.

Suprapubic cystostomy was then done and on exploring the interior of the bladder with the finger, an opening of a diverticulum to the right and posteriorly was felt. The opening was about 1½ inches in diameter, with sharp well defined edges.

The bladder was drained suprapubically—the D'pezzor catheter being led into the diverticulum. The space of Retzius was drained and the incision closed. The bladder was drained continuously and bladder washes given daily. After a week of this routine, the urine became considerably clearer but *B. coli* was again grown in culture.

On 23-5-1944: Surgeon Dr. C. P. V. Menon—under spinal anaesthesia, the bladder was exposed by a 5 inch subumbilical mid line incision. The peritoneum was pushed up. A very large thin walled diverticulum extending backwards and to the right and about twice the size of the bladder was dissected out. During the process the peritoneum which was very adherent was accidentally opened. This was immediately sutured, leaving a very small area adherent to the fundus of the bladder proper. The right ureter was found to open into the diverticulum about one inch beyond its communication with the bladder. The ureter was divided. The neck of the diverticulum about 1½" in diameter was clamped and cut through, the opening being then closed by three layers of sutures. The divided right ureter was then implanted into the bladder proper. The extra vessel space was drained. The bladder was drained superpubically with a Malecot catheter and the wound closed.

During the post-operative course, there was some sepsis in the wound and the patient ran an irregular temperature for about 10 days and was treated with Sulphonamides by mouth. After two week the suprapubic catheter was removed and the bladder drained continuously per urethra. It took about three weeks for the suprapubic wound to close completely and on removing the urethral catheter, the patient found that he could pass urine freely and empty the bladder completely—there being no residual urine on catheterisation, after the patient had passed urine.

The Pathological report on the specimen said that microscopically there was thinning of the bladder wall with inflammatory changes and denudation of the mucous membrane in areas. The muscular wall was intact.

On 14-7-1944: Cystoscopy was again performed under general anaesthesia to view the orifice of the implanted ureter, and it was seen to be functioning well. The cystitis had cleared up. An intravenous pyelogram on 18-7-1944 showed hydronephrosis and hydroureter still present on the right side but the excretion of dye delayed to 45 minutes on the right side in the pre-operative pyelogram now occurred in 17 minutes. (Fig. C & D.)

This is a case of giant diverticulum of the urinary bladder of the Congenital type as shown by the presence of muscle tissue in its wall. There was no obstruction in the lower urinary passages and the diverticulum was causing pressure on both ureters below. Apart from cystitis, there were no other complications like calculus formation or new growth in the sac.

The inability to visualise the opening of the diverticulum into the bladder during Cystoscopy was probably due to its being closed by sphincteric action as is sometimes said to occur.

My thanks are due to Lt.-Col. McRobert, I.M.S., Superintendent, Government General Hospital, Madras; and Dr. B. M. Sundaravadanan, F.R.C.S., Surgeon, Govt. General Hospital, under whom the case was admitted and investigated for permission to report this case.

#### REFERENCES

1. JOLY, J. SWIFT (1923), *Lancet* 2, 445.
2. WARD, R. OGIER (1938), *B.J.S.* 25, 790.
3. KEYNES AND MORLL (1913), *B.J.S.* 31, 187.

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#### ABSTRACTS

*Skin Grafting in the Treatment of Wounds* by Archibald H. McIndoe, F.R.C.S., F.A.C.S. (*Proc. Roy. Soc. Med.*, Dec. 1943.)

The early application of skin to any raw surface is as important as the early immobilization of a fractured bone. This is true whatever the nature of the wound, and wherever it may occur. Though it is widely believed that the only variety of wound meriting a skin graft is an extensive superficial soft tissue injury with loss of skin, the most important results follow quick healing in compound injuries involving tendons, bones, and joints. It is precisely in the field of orthopaedic surgery that the value of early skin replacement should be fully appreciated and more widely practised. The day has passed when healing of extensive skin losses by scar tissue should be countenanced. Treatment of this sort is a surgical crime. The inevitable results of slow healing, particularly in area of functional importance, are contractures and deformity, deep fibrosis of muscle tissue, obliteration of tendon sheaths, periarticular fibrosis with loss of movement in joints, and decreased excursion and power in muscles. The advantage of quick epithelialization is that the progressive fibrotic organization which constantly occurs in an open wound and in the tissue lying beneath it is immediately converted into a process of resolution and absorption of inflammatory exudate with resultant tissue softening. Intact skin is the only efficient barrier to the entrance of infection.

Provided there are no deep foci of infection established in the tissues and sooner a skin covering is obtained the better. Even if it is a temporary covering to be replaced later by another type of graft for functional or cosmetic reasons, its early successful use will sometimes avoid weeks of pain and suffering, and possibly a lifetime of disability and disfigurement from scar tissue contraction or chronic ulceration.

In both burns and traumatic injuries a skin graft may be applied immediately, or after excision of the wound. In most instances, however, and particularly with burns, delayed grafting is the method of choice after infection has been controlled and a satisfactory granulating surface has been produced. But wherever possible the immediate use of a skin dressing is to be preferred. Ideally the treatment of a wound with loss of skin would involve the immediate regrafting of the actual piece lost after suitably pre-

paring it as a free graft. This is sometimes possible, and is always worth attempting. The paper describes a remarkable case of 6"  $\times$  3" dirty, detached skin being washed and used as a Wolfe graft.

Immediate grafting is determined by the degree of wound infection and this by the time interval which has elapsed since injury. Twenty-four hours is permissible with facial wounds, correspondingly less in the trunk and extremities.

Delayed grafting means the application of a skin covering to a prepared granulating surface. Speed in the preparation of such a surface is essential in order to prevent the excessive formation of that thick basic layer of fibrous tissue which is eventually so crippling from a functional standpoint. Thus a traumatic skin loss, free of sloughs from the beginning and treated by an open method should be ready for grafting in seven to ten days. Granulating surfaces developed under plaster usually require a further five to seven days sterilization though occasionally they may be dealt with immediately the plaster is removed. Practically all third degree burns treated by the saline, sulphanilamide and tulle gras method should receive their initial grafts between the third and fourth week.

*The control of infection and the conditioning of the granulating surface.* It is generally agreed that the quickest method of preparing a granulating surface for grafting is by saline and half-strength eusol pressure dressings applied frequently and atraumatically with tulle gras applications to prevent adhesion of the gauze packs to the delicate proliferating surface (McIndoe, 1941, 1942). This is true whether plaster is used or not. 1% acetic acid alternating with sulphanilamide powder is useful for *B. pyocyaneus* but this organism is difficult to eradicate by any known method. The two organisms to be most feared are a haemolytic *Staphylococcus aureus* and a sulphanilamide-resistant haemolytic *Streptococcus*. Experience shows, however, that it is unnecessary and indeed impossible to produce a surface completely free of all these organisms. What is necessary is to reduce the total bacterial flora to a point where a graft will take. The most reliable guide is the condition of the healing edge and its rate of spread. If this is proceeding normally the graft will almost certainly take. Skilful and devoted nursing carried out under aseptic regime is more important than any magical application from a bottle. Dry-heat, ultra-violet or infra-red lights, silver nitrate pencils or caustics should never be used.

The technique of grafting by the Thiersch method is well enough known, and is nowadays helped by the rubbing of granulating areas with sulphonamide powder, and on this, applying the grafts. Exposed tendons, bones and joints require a fresh blood supply at the earliest possible moment. They must receive rather than give nourishment if they are to survive and with their survival preserve movement and function in the part. Experience shows that the use of a pedicled flap is often too long delayed and that the patient lies in hospital for months on end while unavailing efforts are made to get free grafts to take. Technically flaps are difficult to carry through and should be dealt with only by those skilled in their use. The prime indications for pedicled flaps are exposure of tendons or joints in hand, wrist, elbow, and foot, especially around the heel.

*Comment.* "It cannot be said that there is to-day any lack of technical knowledge as to how a given raw surface should be covered with its appropriate skin rapidly and with certainty, whatever the size of the loss or the nature of the underlying lesion. Nor is there any argument as to the desirability of quick healing. It is noticeable, however, that in orthopaedic injuries insufficient attention is paid to this aspect of the lesion with the result that healing is often grossly delayed and functional results heavily compromised. The orthopaedic surgeon should make himself proficient in the use of the free

skin graft in wound treatment. He should also be fully aware of the limitation of this method and the indications for the more complicated but often more satisfactory methods of skin replacement requiring the help of the plastic surgeon," or, better, his own knowledge of the principles and practice of plastic surgery.

N.B.—The first and last paragraphs are deliberate quotations from Mr. McIndoe's paper; it was felt that they expressed themselves so succinctly that it was wrong to condense them further.

T. H. S.

*Quadricepsplasty to Improve the Knee Function by Lieut.-Col. T. C. Thompson.*  
(*Journal of Bone and Joint Surgery, April, 1944.*)

It must be the experience of all surgeons who deal with injuries of the femur, simple or compound, to be faced with impairment of the movements of the knee.

Lt.-Col. T. C. Thompson has clarified and stated that the limitation of movement at the knee joint is not so much due to the extra-articular changes round about the knee joint but due to the changes taking place in the quadriceps muscle especially in the vastus medialis, vastus intermedius and vastus lateralis.

He has from a study of 13 cases shown that the rectus femoris is generally free and is not affected by the inflammatory changes as the other muscles of the quadriceps mechanism. He has devised an operation which is very simple and appears very effective.

He advocates a skin incision on the anterior aspect of the thigh beginning from the upper third of the thigh to the lower border of the patella. The fascia was divided on either side of the rectus beginning from below and extending upwards and limiting it at the place where the muscle appeared normal. After dissection the rectus femoris which becomes free can be drawn aside. The capsule is divided on either side of the patella extending distally until the contracture of the capsule is overcome. He has stressed that the most remarkable change was fibrosis of the vastus intermedius tendon which attaches the under-surface of the rectus femoris and the patella to the anterior surface of the femur interfering with the movements of the knee. He advocates excision of the vastus intermedius completely leaving the fibrosed periosteal covering over the front of the femur. At this stage of the operation he found that the manipulation of the knee to an angle of about 70 degrees well beyond the right angle was possible. The vastus medialis or vastus lateralis are sutured to the side of the rectus femoris if found fairly normal, down to the middle and lower thirds of the thigh. He made no attempt to close the capsule. If the muscles were badly scarred no attempt was advised to suture them to the rectus femoris. In cases where there were old healed sinuses and multiple incisions in either the vastus medialis or the vastus lateralis, the subcutaneous tissue and fat was mobilised and sutured on one or the other side of the rectus femoris in order to produce a new inter-muscular septum and eliminate all the scarred muscle from the remaining quadriceps mechanism. After suturing the skin, the extremity is placed in a Thomas Splint with Pearson attachment to facilitate early movement. He advocates passive and active movements in balanced suspension immediately and found that the recovery was surprisingly rapid.

Bennett recommended quadriceps lengthening operation for similar condition but the pathology described by Lt.-Col. Thompson has clarified the position. The mobilisation of the rectus femoris, cutting away of the fibrosed vastus intermedius tendon and

reconstruction of the inter-muscular septum and early movements is a departure from Bennett's technique and has accelerated the convalescence and improvement of function.

M. G. K.

*Treatment of Carcinoma of the Prostate. (Journal of the Royal Society of Medicine, March, 1944.)*

A discussion on treatment on carcinoma of the prostate was opened by Mr. Clifford Morson, who limited his remarks to surgical measures only. It was discussed that carcinoma of prostate resembles breast cancer in its tendency to form fibroblasts and to metastasise to bones. The lymphatic spread is to glands in the groin, pelvic cellular tissue, iliac bones lymphatics round the rectum, posterior abdominal wall and then to the vertebrae and thorax. Once the disease has spread outside the prostate gland proper, a radical operation is not possible.

Clinical examination of the patient when considered together with the signs and symptoms including a cystoscopic examination can only be of value in suggesting the possibility of cancer. Only a biopsy can give a conclusive evidence.

It was remarked by one of the speakers that men, dogs and lions are particularly liable to cancer of the prostate and that for various reasons he has only investigated the former two only.

Another speaker remarked that treatment by deep X-Rays has to be given to the whole pelvis. 40 to 50 p.c. patients without known metastasis improve with this treatment but sooner or later the growth recurs or metastasis are formed.

Professor Dodds gave a summary of recent work on the effects of injection of Testosterone and estrogens. The Chairman remarked that he has been impressed by the dramatic result of administration of stilbestrol, beginning with 1 mg. t.d.s. and <sup>1</sup>/<sub>2</sub> mg. up to 20 mg. t.d.s. The largest dose given was 3000 mg. in 11 months. About 5 p.c. developed mastitis after getting 500 mg., which is obviated by reducing the dose.

S. B. G

## Association Notes

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7. S. SUBBA RAO—Bangalore.

8. N. MANGESH RAO—Madras.

### The Annual Conference

The Vith Annual Conference will be held in Lahore on 30th, 31st December, 1944 and 1st January, 1945. Rai Bahadur G. D. Kapur, M.S., F.R.C.S., 5, Lawrence Road, Lahore, is the Local Secretary and all members intending to attend are requested to get into touch with him as early as possible.

### Registry of Sarcoma of Bone

It was decided at the last Conference that a Registry of Sarcoma of Bone is to be maintained under the auspices of the Association. Dr. V. R. Khanolkar of the Tata Memorial Hospital, Bombay, has very kindly consented to make the necessary Pathological study of Specimens. All Surgeons are, therefore, requested to send short but complete notes of cases of Sarcoma of Bones coming under their care to Dr. Khanolkar along with X-Ray and Clinical photographs, if any, and a piece of embedded tissue or two unstained slides. It is particularly requested that all Surgeons will co-operate in this endeavour.

## The Library

The attention of all members is invited to the Circular regarding the Library. A separate account has been opened and donations and subscriptions may be sent to the Secretary. Suggestions regarding books and journals to be acquired are welcome. Donations will be acknowledged in the Journal from time to time.

### SUBJECTS FOR DISCUSSION

#### 6th Meeting :

1. *Surgery of the Gall Bladder*—

Opener : Dr. P. Chatterjee, Calcutta.

Seconder : Dr. H. Hyderali Khan, Hyderabad.

2. *Carcinoma of the Breast*—

Opener : Dr. N. C. Joshie, New Delhi.

Seconder : Dr. D. J. Jussawalla, Tata Memorial Hospital, Bombay.

3. *Urinary Lithiasis*—

Opener : Dr. L. B. Joshi, Karachi.

Seconder : Dr. H. L. Vaidya, Kathiawar.

#### 7th Meeting :

1. *Traumatic Surgery of the Skull*—

Opener : Dr. R. N. Cooper, Bombay.

Seconder : Dr. G. D. Kapur, Lahore.

2. *Enlarged Prostate*—

Opener : Dr. S. R. Moolgavkar, Bombay.

Seconder : Dr. S. S. Anand, Lahore.

3. *Fractures of the Neck of the Femur*—

Opener : Dr. B. N. Sinha, Lucknow.

Seconder : Dr. A. K. Talwalkar, Bombay.

#### 8th Meeting :

1. *Carcinoma of the Rectum*—

Opener : Dr. C. P. V. Menon, Madras.

Seconder : Dr. E. J. Borges, Tata Memorial Hospital, Bombay.

2. *Carcinoma of the Cheek*—

Opener : Dr. B. M. Joly, Delhi.

Seconder : Dr. K. M. Rai, Madras.

3. *Hare Lip and Cleft Palate*—

Opener : Dr. S. C. Sinha, Calcutta.

Seconder : Dr. M. G. Kini, Madras.



## 9th Meeting :

## 1. Bone Tumours—

Opener: Dr. D. R. Meher Homji, Bombay.

Seconder: Dr. M. G. Kini, Madras.

## 2. Intracranial Tumour—

Opener: Dr. A. V. Baliga, Bombay.

Seconder: Dr. R. N. Cooper, Bombay.

## 3. Burns—

Opener: Dr. M. R. Munawar Ali, Hyderabad.

Seconder: Dr. G. M. Phadke, Bombay.

## Prize Essay

The offer of a prize of Rs. 150 for the best Essay on "Infections of the Foot" is renewed. The following are the conditions:—

1. The competition is open to all qualified medical practitioners registered in India, who have been in practice for not more than 10 years after qualification.

2. The essay should be based on original work and should be written in English.

3. It should be type-written on one side of the paper only and should not contain the name or other indication of the identity of the competitor. Four copies should be submitted.

4. The name, address and qualifications, however, should be written on a separate sheet of paper and enclosed with the essay.

5. The subject is "Infections of the Foot" and the essay should reach the Secretary before the 1st October 1945.

6. The copyright for the winning essay will remain with the Association of Surgeons of India and will be published in the Indian Journal of Surgery. Other essays will be returned to the senders, if accompanied by stamped addressed envelopes.

7. The Governing Body may, at its discretion, withhold the prize if the essays submitted do not come up to the standard.

8. All communications regarding the above are to be addressed to the Secretary, Association of Surgeons of India, 'Binfield,' Kilpauk, Madras.

C. P. V. MENON,

-Hon'y. Secretary.

## AN APPEAL

The Editor,

Indian Journal of Surgery, Madras.

Dear Editor,

Now that the quarterly meetings of the members of the Association of Surgeons of India, resident in Madras have become a regular feature for discussing some of the surgical problems by demonstrations and talks, may I suggest to you that this must be made a regular feature in all places where there are more than 6 members resident in a particular locality. The proceedings of the society may be reported to the Secretary for incorporation in the Journal of Surgery. I venture also to suggest that members should give an indication of their demonstrations a month in advance so as to evoke a good discussion on the problems by demonstrations of their own experience so as to make the discussion a lively affair and benefit not only the members of the association but also the junior members who wish to attend.

Yours faithfully,

M. G. Kini.

# THE INDIAN JOURNAL OF SURGERY

Vol. VII

MARCH 1945

No. 1

## OSTEO-SPONDYLOSIS CONDENSANS HEREDITARIA

by R. J. WEINGARTEN, M.D. (Cologne) and G. POLITZER, M.D. (Vienna)—*Bikaner.*

Diseases affecting the human skeleton as a whole have been closely studied ever since the introduction of X-rays as a routine clinical method of investigation. The range of observation has been so widened that all phases of bone changes could be examined with precision and typical features corresponding to certain clinical entities were established.

This applies to a large variety of osseous alterations effected by now well known causes, e.g., avitaminoses (rickets, osteomalacia) endocrine disorders (hyperparathyroidism, acromegaly) and metabolic disturbances (*Morbus Gaucher*, *Schueller-Christian's Xanthomatosis*).

But there are a number of rare skeletal diseases whose origin is completely obscure. They are frequently met with in several members of one family and the role of heredity has in many instances been further emphasized by a scrutiny of the genealogy showing different generations affected.

We had the opportunity to study a systemic disease of the skeleton belonging to this group and not known until now.

The first case was observed by one of us (W) in February 1944. Gazi Khan, a Mohammedan peasant, 40 years old was admitted in the P. B. M. Men's Hospital, at Bikaner for stiffness of his back and difficulties in walking. His mother had been afflicted in the same manner for 8 years and died a complete invalid at the age of 40. One elder and one younger brother have got similar complaints.

The personal history is briefly as follows: Twenty six years ago he had pain and

swelling of many joints and was cured after treatment in one of the District Hospitals in Bikaner State. No relative records could be traced. Nine years ago one knee became suddenly swollen and painful. This subsided with massage after a short time. A little later, he noticed vague discomfort in his back and he found it difficult to squat down and to get up. After resting, his legs used to be rigid, but became normal after a little walking. This condition worsened very gradually and lately his back had been quite stiff, his legs appeared wasted and he was no longer capable of doing his daily work.

The findings were: General condition corresponds to social status (he belongs to a community of illiterate; very small landholders living poorly at the best of times). He stands with a pronounced stoop and his gait is slow and hesitating with small shuffling steps. The chest is flat and does not in the least move with respiration, which is purely abdominal. The ribs are wide and the intercostal spaces are considerably narrowed. Kyphosis of dorsal and lumbar spine with slight scoliosis of the lower dorsal part. The whole spine is completely immovable. No tenderness. There are hard and irregular protuberances palpable at the deltoid, radial and ulnar tuberosities and the upper parts of the medial surfaces of the tibiae. All muscles of the lower limbs are atrophic to a medium extent, motor power is poor and movements are limited on account of severe spasticity. Deep reflexes of both legs are highly exaggerated and Babinsky's reflex is positive on slight touch of the sole. All sensations are present and there is no ataxia. Cremaster and abdominal reflexes are absent. Upper extremities are quite normal, cerebral nerves unaffected and

memory, and intelligence, unimpaired. Physical examination was negative in every other respect.

The two brothers of Gazi Khan were sent for.

Raju Khan, 45 years old, gives a very similar history. His complaints started about 6 years ago, but advanced more rapidly so that he now depends on the help of another person for moving about. The findings in his case are essentially the same. While atrophy and spasticity of his leg muscles are more pronounced, all other clinical signs are identical with those of his younger brother.

Karim Khan, 35 years, has stiffness and occasional pain in his back since 5 years. The results of his clinical examination do not differ from Gazi Khan's, but he is yet able to move about more freely.

All routine laboratory tests were carried out. Detailed results are omitted. It may be particularly mentioned that there was no anaemia and no leucocytosis. Serological examinations for syphilis were negative. The sedimentation rates were moderately accelerated. The serum calcium, however, was found to be significantly below the normal level 7.7 mg % in Gazi Khan and 6.5 mg % in Raju Khan (method of Clark and Collip). The serum phosphorus was within normal limits. Karim Khan could not be as thoroughly examined as he consented to stay in hospital for a very short time only.

The X-ray examination of the skeletons of these three brothers showed gross changes which were most strikingly congruent in nature and degree in spite of a difference in age of 10 years between the eldest and the youngest. To demonstrate the characteristic appearances generally only one picture of any one area is, therefore, reproduced.

The A. P. view of the spine shows two remarkable features. One is a general and heavy condensation of the bodies of the vertebrae in which any cancellous structure is no longer distinguishable. Secondly, the lateral outlines of the vertebrae are irregular and ill defined while their upper and lower surfaces are sharply visible. Promi-

nences arising from the lateral borders of the bodies join together forming thin bony bridges connecting the terminal plates of two adjacent vertebrae. They are localised laterally while the anterior borders show hardly any changes. This is clearly marked in the lateral-view which is not reproduced in this paper. The transverse processes and the heads and necks of the lower ribs have very irregular outlines and cannot be distinctly separated from each other. This appears to be due to bony protuberances as well as to ossification of tendons and ligaments inserted on them.

The pelvis displays severe condensation of the bony structure. There is nowhere normal lamellation. The condensation is particularly marked in the acetabulum. The membrane filling the foramen obturatum is partially calcified. The superior and inferior pubic rami are thickened and coarse and the inferior one shows bony proliferations. The outlines of the iliac bones are more regular. Some muscle insertions and intra-pelvic ligaments show ossification.

The ribs are very coarsely broadened. In addition to their condensation there is ossification of the inter-costal muscles resulting in the appearances of teeth-like prominences of various sizes forming a lace pattern of the posterior intercostal spaces. The course of the ribs is steep, which with their general broadening, reduces the space between them to such an extent that no proper view of the lungs is obtained. The cartilaginous parts of the ribs do not appear to be unduly ossified.

The scapula is intensely condensed. Its obtuse margin is convex, with irregular protrusions giving it the aspect of saw-teeth. This is apparently due to calcification of tendons and ligaments inserted there.

The lateral-skull view shows an extraordinarily thick walled calvarium. The sella turcica is well defined and rather on the small side. The insertions of the posterior clinoid ligaments (ligamenta petro-clinoidea) are calcified. The occipital bone is of particularly great thickness and on its lower surface the insertions of muscles and ligaments are ossified.



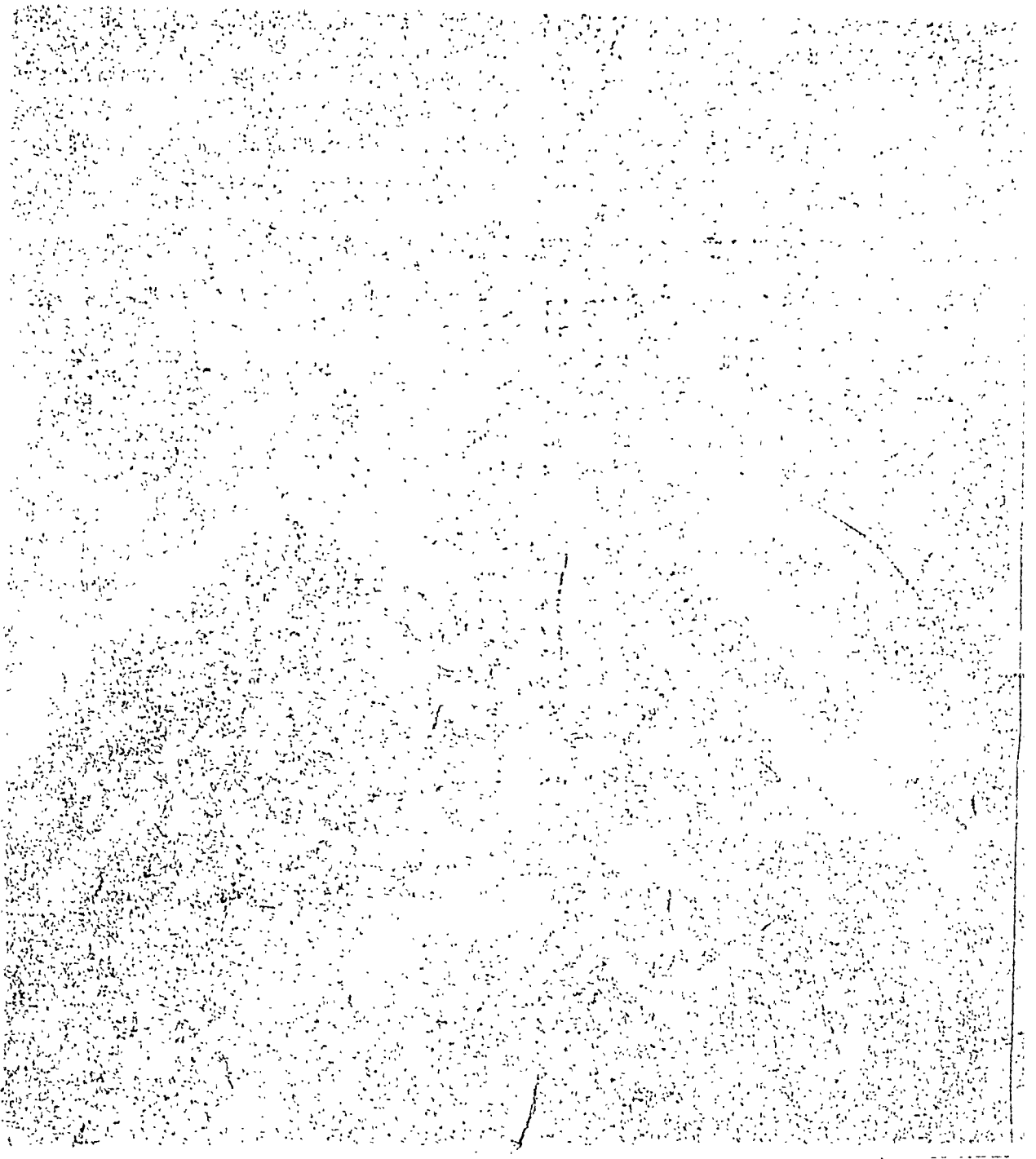




Fig. 2.

The ribs are thickened and condensed to an extent that the structure of the lungs is hardly visible through the cleft like intercostal spaces







Fig. 3.

The ribs are thickened and condensed to an extent that the structure of the lungs is hardly visible through the cleft like intercostal spaces





Fig. 8. Lateral view of Skull of Karim Khan

The Calvaria is thickened. The sella is of normal size

Fig. 9. Shoulder joint of Gazi Khan

Saw tooth shaped exostoses of the margo obtusus scapulae and sclerotic islands in the humerus

10. Pelvis of Karim Khan

Apart from general eburnation of the skeleton exostoses on the ischiae bones and at the insertion of the obturate membranes



All the long bones show a fairly regular condensation by which the density of the compacta is emphasized, but its demarcation towards the spongiosa is easily distinguishable and the marrow space clearly preserved. The most conspicuous change concerns the insertions of large muscles, which, clinically palpable as irregular hard structures, appear in the x-ray picture either as broad and rounded prominences or as irregularly shaped spurs.

The ossicula of the wrist present a peripheral condensation while the centre retains its normal structure. Identical changes are noted at the phalanges of the digits and toes and the metatarsals.

Gazi Khan presented himself for readmission in July 1944, 5 months after his discharge. His condition had fast deteriorated. His legs had become more rigid and much thinner and he was unable to move about of his own. He consented to a myelography. The cisterna magna was easily reached and 5 c.c. of clear spinal fluid were withdrawn. Then iodised poppy seed oil was very slowly injected. After two minutes when 1.75 c.c. had been introduced the patient complained of a severe headache. The injection was at once stopped. A little later there was severe nausea and perspiration, lasting for about 10 minutes. All these signs subsided gradually and x-ray pictures in an erect and horizontal position could be taken. They revealed a complete block in the downward passage. In the vertical position a cone shaped depot of oil is seen above the atlas, while in a lying posture smaller oil deposits of various sizes can be seen in the sub-occipital subarachnoidal spaces. A picture repeated two hours after the patient had remained in an erect posture, showed the oil in the same place, none of it having descended into the spinal subarachnoidal space. That day Gazi Khan complained of headache off and on, but his general condition was satisfactory. At 9-30 P.M., about 12 hours after the injection, he suddenly collapsed and died from respiratory failure.

An autopsy was not permitted, but a small laminectomy was allowed to be performed. The posterior vertebral arches were completely petrified and it was extra-

ordinarily hard to gain access to the cord, of which D3-D5 approximately was removed. Major Leo Krainer, M.D. (Vienna), kindly examined it. His report reads: "No pathological changes detected especially no primary or secondary degeneration." A piece of rib was removed and sent to Dr. R. G. Dhayagude, M.D. (Bom.), Head of the Department of Pathology and Bacteriology, Seth G. S. Medical College, Bombay, to whom we are much obliged for the following histo-pathological report:

"Naked-eye inspection—The rib appeared to be thick and solid. A transverse section taken from it in its greatest dimension measured 1.0 x 2.0 cms. A section taken for comparison from a normal rib cut in the same way measured 0.6 x 1.6 cms.

Microscopical examination—Macroscopically in the stained sections the cortex could not be recognised from the spongy medullary portion which it is quite easy to do in a normal rib.

Microscopically the osteogenic layer of the periosteum was not well differentiated from the cortex which was made up of thickened and slightly irregularly arranged lamellae. A few of the lamellae situated beneath the periosteum showed evidence of halisteresis. The bony processes entering into the medullary region were markedly thickened, irregular and showed anastomoses with similar processes on the opposite side, encroaching to a considerable extent on the bone marrow, which occupied small areas in between the processes. The bone marrow in these areas was cellular and did not show much of fatty tissue. The lamellae composing the bony processes were thick and irregular in their arrangement. The cementing lines between these lamellae were very prominent. In some of these lamellae small irregular areas taking a bluish discoloration were noticed in sections stained with hematoxylin and eosine. They indicated that a process of calcification of the newly formed osteoid tissue was taking place. The fibrillar network of the osteoid tissue was coarser in the bony processes than in the peripheral cortical zone.

The sections of the rib show formation of new osseous and osteoid bone tissue which is irregular in its structure. It also shows

evidence of a small amount of halisteresis going on simultaneously with the process of calcification which is predominant in the bone processes."

Only one more member of the family could be examined, the 19 years old son of Raju Khan. He had no complaints at all and appeared clinically quite healthy. The x-ray examination of his skeleton brought clear evidence of low grade condensation of bones and particularly the ribs were broad, clumsy and dense.

## DISCUSSION

With one or some of the bone changes described we are familiar as they occur in diseases already known. In many cases of acromegaly we meet ossifications of ligaments and muscle insertions though rarely to the extent observed in our cases, but condensation of cancellous bone is not found. None of our cases had an acromegalic appearance, the sellae turcicae were small and well defined and in fact any evidence of pituitary disease was lacking.

Heavy condensation of bones is a typical feature of osteo-sclerosis fragilis (osteopetrosis, marble bones, Albers-Schoenberg's disease No. I) which in addition to completely structureless chalky bones is characterised by spontaneous fractures and a progressive anaemia of the leuco-erythroblastic type connected with the concentric narrowing of the marrow space. In our 3 cases there were no signs of anaemia nor had any fractures occurred. Also contrary to osteo-sclerosis fragilis, where flat and long bones are equally affected, in our cases the condensation of flat bones predominated. Ossification of ligaments and muscle insertions does not happen in marble bones diseases.

The rare hereditary acromegaloïd osteosis is distinguished by thickening of bones of the extremities and periosteal dispositions, especially of the forearms and lower legs. *Friedreich* and *Oehme* have described the anatomical and *W. Mueller* the radiological signs. Usually several members of one family, mostly males, are affected. Pelvis and vertebrae, however, are always found to be normal and the central nervous system is not involved.

In melorheostosis (*Leri's disease*) only one extremity is usually involved. In rare, more extensive cases it affects the bones of one side of the body and even in one exceptional case, where both sides showed typical changes (*Carpender, Barker, Perry and Outland*) the difference in the extent of bony alterations between the two sides was striking, while in our cases there was a pronounced bilateral congruity. Contrary to melorheostosis which affects predominantly the limbs, spine and ribs showed the more marked changes. The unique striated shape of hyperostoses and the absence of calcifications of tendons and ligaments in *Leri's disease* offer a clear line of differentiation.

Recently fluorine in drinking water has been held responsible for the occurrence of spondylitis and skeletal fibrosis. Although the symptoms described in this chronic intoxication show only a faint resemblance to those observed in our cases, a careful, systematic examination of the school children in the city, where our patients had always lived, was undertaken. None of them exhibited the typical mottled enamel, which is considered an early manifestation of fluorosis and which by years precedes the skeletal disturbances.

The presence of bone condensations and ossifications of muscle insertions and ligaments concurrently with central-nervous signs of the spastic atrophic type (clinically identical with the syndrome of amyotrophic lateral sclerosis) is the outstanding feature of this new disease and, judging from 4 cases, the mother and her 3 sons, it appears to produce clinical signs in the 3rd decade of life and after a slow steady course leads to complete invalidity in about 10 years. The bone signs obviously precede subjective symptoms by a considerable time, as the son of one of our cases revealed initial, but typical skeletal alterations without any clinical evidence of disease whatever. The central nervous system is apparently damaged in a peculiar manner, on which the histological examination of a piece of cord, D3-D5, has thrown no light. Possibly at a lower level better information would have been obtained. One is tempted to assume proliferations of the inner border of the vertebral arches (vide also the result of lipography) encroaching on lateral-

anterior tracts. The expansive ossification of ligaments elsewhere might let one consider a similar intraspinal process. The only substantial fibrous structures are the ligamenta flava extending from the lateral to the posterior part of the arch, where they have their greatest thickness. But there were no signs of posterior compression nor any root symptoms to lend support to this explanation.

We propose for this disease the name: Osteo-spondylosis Condensans Hereditaria. Osteo-spondylosis denotes that the disease affects the skeleton as a whole but with a marked predilection for the vertebrae. The affix-osis is to emphasize the lack of inflammatory reaction. Condensans and Hereditaria are self explanatory. We have omitted "deformans" on purpose in order to avoid nomenclatory resemblance with Paget's bone disease. The name has been chosen from the objective radiological appearances as they seem to be strikingly pathognomonic and to precede (if not cause) the central nervous symptoms.

### SUMMARY

- (1) A new hereditary skeletal disease is described.

- (2) Bone changes consist of severe condensation of flat and to a lesser extent of long bones and exostoses due to ossification of ligaments and muscle insertions.
- (3) The central nervous system is simultaneously involved showing signs of amyotrophic lateral sclerosis.

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## TERATOMA OF THE TESTIS

by J. C. PAYMASTER, F.R.C.S., D.C.O.G. (London)—Bombay.

Even up to the present date not much is known about the origin of the malignant Tumours of the testis.

Kocher in 1887 suggested that the majority of malignant tumours of the testis were teratomatous in origin. Chevassu in 1906 disputed this suggestion and stated that the majority of the malignant tumours of the testis was derived from the spermatoblasts and applied the term "seminoma" to them.

Ewing believed that all teratomas of the testis arose from sex cells, most frequently situated in the rete testis. The sex cells are totipotent and may produce any of the tissues derived from the three primary

layers. There seems to be a great tendency for one type of tissue to outgrow the other and this is observed in the predominance or presence of one particular type of tissue in the tumour.

Ewing's classification is the most suitable one and we adopt that in our hospital.

He divides teratomas into (1) adult embryoma or teratoma (2) mixed tumour (3) embryonal malignant tumours: this includes the seminomas, adenocarcinomas and chorion epitheliomas.

25 cases of teratomas of the testis were seen at the Tata Memorial Hospital during the period of three years 1941-1944 out of a total of 6,500 cases.

In 22 cases we have the histological evidence of the tumour. These are as follows :

- (1) Adult teratomas — 2 cases
- (2) Mixed teratomas — 1 case
- (3) Embryonal teratomas — 19 cases

*Adult Teratomas* probably comprise less than 10 per cent of all teratomas. They grow slowly and remain localised. Histologically they are found to be composed of adult tissues and comprise definite rudimentary organs. Portions of a variety of organs and tissues have been observed in these growths.

*Mixed Teratomas* contain adult as well as malignant embryonal tissues. They metastasise frequently and the metastases are always from the more malignant parts of the tumour.

*Embryonal Teratomas*—these are the commonest malignant tumours of the testis ; they are highly malignant and spread rapidly through the lymphatics and the veins. Histologically, the tumour is composed of large round or polygonal cells of embryonal type, diffusely scattered or arranged in alveoli. The stroma is often richly infiltrated with lymphocytes. Ewing states that "this common tumour of the testis is always a one-sided development of a teratoma and is not derived from the spermatoblasts."

*Spread of the disease.*—The tunica albuginea keeps the tumour within its limits till extension occurs by way of the lymphatics and veins, and very occasionally by direct spread. The lymphatics of the testis ascend with the spermatic vessels through the inguinal canal to the lumbar lymph nodes. They have no relation either with the lymphatics of the opposite testis or with the inguinal nodes. In the lumbar region, the lymphatics spread out and make connection with the nodes extending from the bifurcation of the aorta to the celiac axis. From this point onwards, the path of spread extends through the diaphragm and the mediastinum to the supraclavicular regions, particularly on the left side.

The lumbar area of the opposite side is said to be affected by retrograde spread downwards from the epigastric nodes. The low grade teratomas have a tendency to

spread by direct extension, affecting the epididymis and the cord. The mixed teratomas or the intermediate group usually spread by lymphatic embolism.

The highly malignant embryonal tumour such as embryonal adenocarcinoma and chorion epitheliomas spread by way of the venous channels most frequently to the lungs.

The first symptom that drew the attention of the patient was the painless swelling of the testis, and this was noted in 16 of our cases. In 2 cases the metastases were noted before the primary was discovered.

Relationship of trauma has always been a very disputed question in these cases. However, it has been recorded in 19 out of our 25 cases. The average age recorded is 35 years. The youngest case was in a child of 15 months and the oldest person is a man of 47 years.

It has been proved beyond doubt that an abnormally descended testis is definitely much more liable to undergo malignancy than a normally placed one ; and that the incidence is certainly greatest in the abdominal variety.

*Diagnosis.*—Early diagnosis of teratoma is extremely important as is seen from the observation of Dean, of Memorial Hospital, New York, who found metastasis in 67 per cent of cases even though they consulted the physician within three months of the first symptom.

It is very important to bear in mind 'teratoma' when one is examining a testicular swelling in a young man.

On palpation the testis is found to be smooth, elastic and uniformly enlarged, the shape of the testis is usually preserved. The tumour is seldom sensitive.

Some idea of the variety of the tumour could also be formed from clinical examination. It is stated that adult teratomas are usually large, irregular and contain hard and cystic areas ; the tumour may encroach upon the epididymis and the cord and have no metastasis. If the tumour is small, smooth, elastic, with no extension into the epididymis, the shape of the testis well maintained, with evidence of metastases in



the pelvis or abdomen, it is most probably a seminoma or an embryonal carcinoma.

In late stages when metastases have occurred it is very simple to diagnose. The lumps in the epigastrium and the supra-clavicular regions give out the nature of the tumour. X-ray picture of the chest will reveal the evidence of intrathoracic metastases.

Biopsy of any nature either aspiration or formal is considered very dangerous and unsound in teratoma of the testis. It injures the tunica albuginea and hastens extension outside the testis.

The use and interpretation of the Ascheim-Zondek Test is interesting. The test depends upon the estimation of the follicle stimulating factor excreted in urine; and when correctly interpreted, helps a great deal in diagnosis and prognosis of the teratomas of testis.

Many theories have been put forward to explain the appearance of follicle stimulating substance in teratoma of the testis. One of the theories is that the teratoma produces a hormone which in turn stimulates the basophilic cells of the anterior pituitary organ to secrete the follicle stimulating substance.

It is a quantitative test performed on immature mice of a certain age; and the results are given in mouse units per litre of urine. The interpretations are as follows:—

In a person with a testicular tumour who has had no treatment of any kind,

(1) If the test is negative it means that most probably the man has no tumour; however, the test should be repeated as very seldom an adult-teratoma may exist without the A-Z test being positive.

(2) If the test shows 500 m.u. or under, most probably it is an adult teratoma. Very seldom inflammatory conditions like syphilis, tuberculosis or interstitial orchitis give a positive test under 500 units.

(3) Seminoma of Testis is most probably present when the test shows 500-1500 mouse units.

(4) The more malignant tumours like adenocarcinoma give high values of 2,000-10,000 units.

(5) If the test shows above 10,000 units we are definitely dealing with chorion epithelioma.

*Treatment of teratoma of testis is considered under two main headings:—*

(1) Cases with a testicular swelling but neither clinical nor radiological evidence of metastasis anywhere.

(2) Obvious cases of teratoma of testis with either clinical or radiological evidence of metastasis. Such cases offer no difficulty at all, for the treatment of choice is a thorough course of deep X-ray therapy through the various ports which are directed over the primary and the routes of spread.

The treatment of an early, small teratoma strictly localised to the testis is the subject of great importance and discussion.

In such early and indefinite tumours the differential diagnosis of traumatic and infective conditions like syphilis, tuberculosis, interstitial orchitis, etc., creep in. Here the A-Z test is of great value. If the test is negative, most probably it is not a tumour. It is wise to treat such a swelling as a traumatic or infective condition keeping a very close day to day watch as regards pain, size and consistency. The A-Z test is repeated in three weeks' time and if no improvement is observed in the swelling, then a simple orchidectomy is done and the excised testis is subjected to a thorough microscopic examination.

If the A-Z test is positive and its value is 500 m.u., or under, as stated before, it is most probably an adult teratoma but values above 500 units mean more malignant tumours of the testis. In dealing with such tumours there are two schools of thought. One school insists on a very thorough preoperative course of deep X-radiation justifying such a procedure from the improved 5-year survival rate. But in several of their cases the diagnosis has not been substantiated by the histological proof, because they state that the preoperative radiation has been so effective that the entire tumour is destroyed, the tumour cells disintegrate and very often the tumour is converted into a mass of homogenous material very difficult to differentiate from an ordinary hematoma.

The other school does not believe in pre-operative radiation. The followers of this school straight away perform a simple orchidectomy taking all due precautions whilst handling the malignant growth. To avoid all possible chances of dissemination of tumour cells during the operation, it is absolutely essential to sever the cord structures high up, as the first step of the operation, before the tumour is handled. Primary orchidectomy gives the pathologist a chance to examine carefully every bit of the tumour before it is radiated. It is also logical that the earlier the removal of the primary from the body, the less are the chances of subsequent metastasis. These cases are of course given a thorough post-operative course of X-ray therapy. In the subsequent follow-up the A-Z test is repeated from time to time to check up for evidence of metastasis along with thorough clinical and radiological examinations. The number of cases seen by us is quite small and thus no definite view could be expressed but we are more inclined to fall in with the second school of thought.

Reviewing the literature on the treatment of teratoma of the testis, one finds that radical surgery of the type suggested and performed by Chevassu and Hinman is almost given up in favour of radiation treatment. By surgical treatment, the 5-year survival

rate has been given as only 17 per cent in the best of hands. Of course, simple orchidectomy gave even less than 6 per cent of 5-year survivals. The best results are obtained with a systematic method of deep X-radiation. The most recent figures given by R. S. Fergusson are as high as 40 per cent. The teratomas of the testis vary considerably in radiosensitivity as they do in their histology. Thus there is no one rigid technique of radiation. The factors used in our hospital are—200 K.V., 15 Ma, 0.5 Cu and 1 mm Al filter, 50 cm. TSD, daily dose of 200 r or more is given through the following ports until a dose of 2000 r or more is given per port.

The ports are marked out as shown in the accompanying figures. No treatment is considered thorough unless the entire route of spread is radiated.

The abdomen is divided into 5 primary ports; 3 anterior and 2 posterior. These ports cover the path of the metastasis upto the epigastrium.

Port I is a triangular one; it radiates the primary tumour and the spermatic cord till its passage into the internal abdominal ring. In cases where the primary tumour has been excised, it takes care of the operated area. The penis and the other testis are very carefully and cautiously protected from radiation by lead shields.

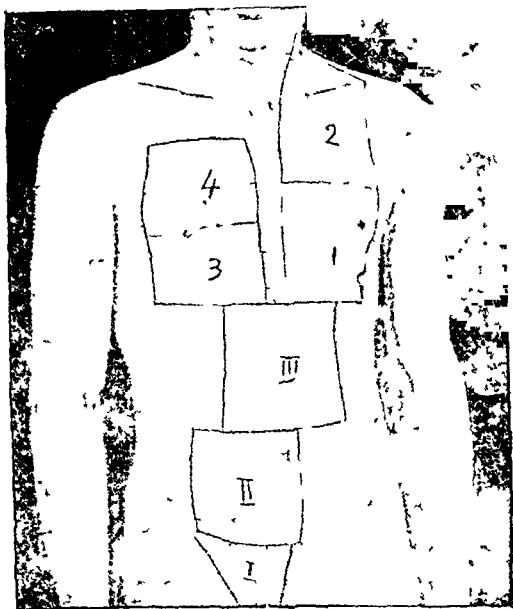


Fig. 1.

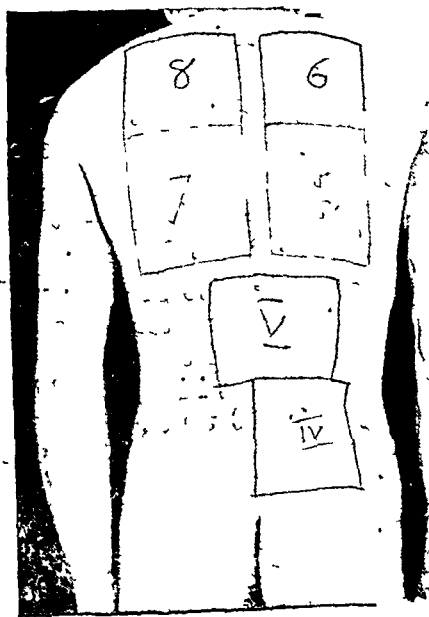


Fig. 2.

Port II. This port is a square. Its median border is well beyond the midline. Its upper border is at the level of the umbilicus. Its outer border is in a straight line drawn upwards from the anterior superior spine.

Port III. This port may be a square or a rectangle. The medial 1/3 of which crosses over to the opposite side. It takes care of the epigastric and celiac nodes. The upper margin of it reaches the ensiform cartilage.

judgement of the radiologist. At the Tata Memorial Hospital, we believe that every case of teratoma of the testis particularly that belonging to the more malignant group should have a thorough course of post-operative deep X-radiation to the 5 primary abdominal ports, as shown in figures 1 and 2.

After the completion of this treatment, although there be no clinical nor radiological evidence of mediastinal metastasis still

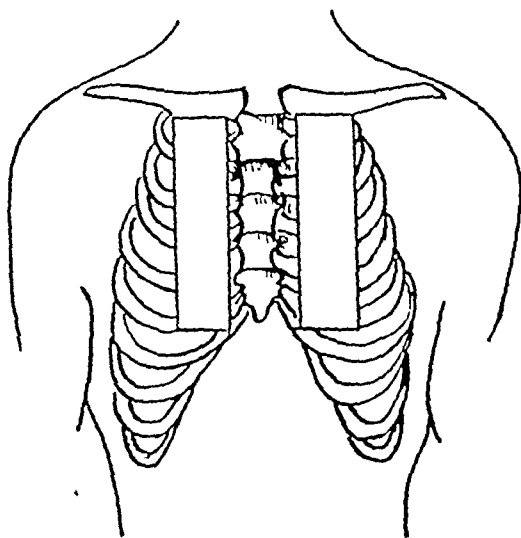


Fig. 3.

Port IV. Is marked on the posterior aspect to correspond exactly to Port II.

Port V, corresponds posteriorly to the Port III.

The spread upwards through the diaphragm and mediastinum is taken care of in a number of ways. Some authorities radiate the thorax and the supra-clavicular space with 8 ports, 4 anterior and 4 posterior. There are others who would radiate with only 2 ports, 2 anterior and 2 posterior, the beam of radiation being directed obliquely inwards to take care of the mediastinum and the thoracic duct with its extensions.

The selection of the number of ports, their size, the order in which they are radiated and the total dosage are factors which constantly tax the experience and the

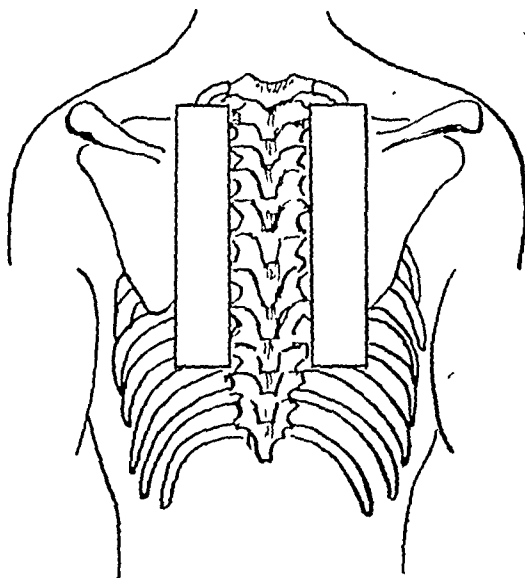


Fig. 4.

the mediastinum is radiated through 4 ports as shown in figures 3 and 4; provided the general condition of the patient - permits this amount of radiation.

The Tata Memorial Hospital has been functioning only for the past three years, hence it is not possible for us to speak of any five year results. However, the following are the results:—Out of the 25-cases seen at the Hospital only 18 cases received treatment. 6 of whom had orchidectomy performed outside and were referred to us for deep X-radiation. All these 6 cases were patients referred to us from various Military Hospitals of India. Only 2 of them are followed for the past 2 years and are reported free from any disease; the rest of them have been shipped home and we have not heard from them. Of the remaining

cases, 3 had orchidectomy done in the Hospital—one of them died in 6 months from abdominal metastasis. The remaining 2 are well and alive for a period of one year and eight months respectively. The rest of the cases were advanced problems and received only palliative courses of deep X-radiation.

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### SOME NUTRITIONAL PROBLEMS OF SURGICAL PATIENTS

by I. S. RAVDIN, Colonel, Medical Corps, Commanding U.S.A. Forces, Ledo.

I am very pleased to attend this Congress and to bring you greetings from the American College of Surgeons, the American Surgical Society and from the oldest Medical Society in my country,—the College of Physicians of Philadelphia. It is unfortunate that we are separated by so long a distance, but it is one of the few happy circumstances of war that new friendships are developed and that clearer understandings frequently are brought about as a result of the new friendships that are made. Science recognizes no boundaries; it never has been, and I hope never will be, provincial in its outlook. The scientific discoveries of each of the Allied countries have been rapidly made available to each other. Surely this has been true in Medicine.

Some years ago my associates and I became interested in various problems of nutrition as they effected the course of surgical disease and it is of some of these problems that I should like to talk today. The subject is of universal importance, and of wide spread application not only in my own country, but from what I have seen these past two years, of equal or even greater importance in the East, where in densely populated areas a considerable por-

tion of the people are on a bare subsistence level or, even below that.

At the beginning of the present century the basic Medical Sciences began rapidly to expand so that a more comprehensive picture of normal function became available. To correct abnormal physiological reactions one had to have a knowledge of normal function. A mere knowledge of anatomy and pathology was not enough. Surgeons, who are traditionally conservative, were indeed often too slow in accepting the results of physiological investigations and in applying these to the problems presented by individual patients. Even when such investigations were accepted they were applied, all too frequently, with a lack of critical judgment.

For a surgeon to become interested in nutrition may well be considered heresy for general nutrition has not in the past been considered a matter of concern to the surgeon except for some vague relationship to resistance, to tissue repair and to rapidity of convalescence. That it might seriously affect the morbidity and mortality of many operative procedures is however becoming better recognized. In most instances the loss of weight of a patient in a

surgical ward has been accepted as an inevitable occurrence, but it should be remembered that usually this loss of weight is the physiological expression of the fact that food intake has failed to meet the energy requirements of the patient.

All too frequently we hear the glib statement "glucose balance has been maintained by intravenous therapy," when in reality the administration of 3,000 c.c. of a 5 per cent solution of glucose provides but 600 calories to a patient, who at rest in bed and afebrile requires 1,600 or more calories. The extra thousand must come from his body stores and all too often in the surgical patient, these are already well below the normal.

*It is now possible to demonstrate that the nutritional state of our patients does bear a direct relationship to morbidity and mortality to the rapidity of convalescence, and to numerous other factors. Time will not permit me to review all aspects of this important subject. I shall merely mention a few in which I and my associates have interested ourselves.*

*Hypoproteinemia.*—The prolonged restriction of protein in the diet, the excess loss of protein through the kidneys or through suppuration, or the failure to synthesize the split products of protein digestion leads to a reduction in the concentration and total amount of the plasma protein and a reduction in the protein of the body as a whole.

When the concentration of the plasma proteins is reduced from the normal of approximately 7.0 grams per cent, fluids begin to leave the vessels resulting first in a latent and finally, when the accumulations in the extravascular reservoirs become great enough, in evident tissue edema. This train of events first elucidated by Starling in England occurs whether or not the plasma crystalloids are of normal concentration.

The occurrence of edema in surgical patients is too often due to a lack of knowledge of the fundamental physio-chemical factors which control the movement of fluid across vascular membranes. While the osmotic pressure exerted by the plasma crystalloids is great (5,000 to 6,000 mm. mercury) as compared to that of the plasma

protein (27 mm. mercury), it is of little importance in keeping fluids in the blood vessels, or of drawing them back once they have escaped, for the crystalloids are freely diffusible through vascular membranes.

Latent and evident edema have become much more frequent in surgical patients as the enthusiasm of surgeons and their house officers for the intravenous administration of fluid has increased. It is, in fact, now well recognized that the administration to patients of large amounts of sodium chloride tends to exaggerate the edema occurring at any given plasma protein level. Likewise we have found that edema can often be controlled in hypoproteinemic patients if the intake of the sodium ion is restricted. In certain conditions associated with hypoproteinemia, such as in extensive superficial burns, the administration of large amounts of sodium chloride results in the further loss of protein from the vascular system and a similar condition no doubt exists in other lesions associated with trauma and shock.

During the past few years we have heard more and more about the value of plasma or serum transfusions. The discussions of the value of plasma or serum in correcting hypoproteinemia have nearly uniformly failed to consider that hypoproteinemia very often is but one manifestation of a profound disturbance in protein storage in the body. In nearly every instance of hypoproteinemia in surgical patients there is also a loss of protein from important store-houses of the body. In this sense we must come to look upon the plasma protein and the stores of protein in the body as in large part complementing each other.

Addis and his associates, who studied the loss of protein from various body tissues during starvation, found that the liver loses so much more of the original protein content than any other organ that they suggested "that it may be a depot for stored protein and that this special sort of protein may be used during fasting in much the same manner as glycogen during a fast."

Protein deficiency as expressed in hypoproteinemia may give rise to so intense an edema following a gastro-intestinal anastomosis as to mimic in every way a mechani-

cal defect of the technic of the anastomosis. The impediment to normal gastrointestinal flow is frequently the result of an accentuation and prolongation of the edema associated with hypoproteinemia by the edema of the trauma of operation. In the presence of a lowered colloid osmotic pressure of the plasma, fluids cannot normally find their way back into blood vessels, the size of the new stoma is reduced, and the area made more rigid by extensive fluid extravasation.

On a number of occasions we have seen such stomata fail to function normally until by one means or another the hypoproteinemia was overcome. When this was accomplished, normal emptying took place and the fear that the complication was due to a defect in the method of anastomosis gave way to the feeling that we should pay more attention to the factors which are responsible for edema formation.

Those surgeons who state that hypoproteinemia is rarely if ever a cause of deficient gastric emptying ignore the fact that dogs which have not had an abdominal operation show an increase in gastric emptying time with a progressive decrease in the concentration of the plasma protein. To deny that this process is accentuated following resection of the gut with its coincident trauma is to deny the Starling hypothesis.

We have administered intravenously to man and dog various acid and enzymatic hydrolysates of protein in an attempt to increase the concentration and total amount of the plasma protein. We have obtained evidence that hypoproteinemia can be in part corrected by this procedure even when foodstuffs are withheld by mouth, but this process is a slow one. In the dog, where it has been possible to determine the total plasma volume during various phases of the experiment, we have not found significant evidence of marked plasma protein regeneration solely upon intravenous therapy. There is some evidence however, that such therapy leads to an increase in the protein content of certain important viscera, and it would appear that tissue stores of protein are being restored before the plasma stores are replenished. A similar situation exists

even when plasma is used, for it is also utilized to replace in part the depleted stores of visceral protein.

Studies which are now being conducted by my associates demonstrate, in a striking manner, the difference in the rate of restoration of the stored protein with different diets and more especially upon different types of protein. This aspect of the problem requires careful investigation but the results which may be obtained from such studies will probably be of great value to clinical medicine. We now know very little about the regeneration of plasma protein from amino acids and still less about parenchymal regeneration, and yet these are problems which we should now be attempting daily to solve in our patients.

*Visceral Protection and Diet.*—We have learned a good deal about the tissue protection which can be obtained by the administration of an adequate dietary. Twenty-seven years ago Opie and Alford reported that the incidence of necrosis of the liver following the use of chloroform could be greatly reduced if a diet high in carbohydrate was administered to dogs for several days prior to anesthetization, and the increased susceptibility occurred if the diet was high in fat. Data subsequently published by Davis, Hall and Whipple and Graham confirmed the earlier work.

Surgeons began to administer carbohydrates to their patients and because the appetite of the individuals was often poor, and because surgeons were led to believe that intravenously administered glucose was preferable to ingested carbohydrate, it was not long before the intravenous route became the method of choice. Surgeons, internists, and even physiologists apparently accepted not only the data which these investigators presented but the reasoning which led to certain forms of therapy. This in spite of the fact that Moise and Smith, in 1924, called attention to the inadequacies of the diets used by the early investigators, which diets were neither pure, nor adequate to meet the energy requirements of growing dogs.

Soskin and Hyman have recently stated that there is a physiological basis for intravenous glucose therapy. They stated fur-

ther: "It is now generally accepted that acute and chronic destructive or degenerative processes of the hepatic parenchyma are best treated with large amounts of carbohydrate. A difference of opinion exists, however, concerning the advantages of the intravenous administration of dextrose if the patient can take the necessary dextrose or carbohydrate by mouth." More recently Sears and Banks have published work in which they accept the conclusions originally proposed by Whipple and his associates for they state, "Abundance of hepatic glycogen forms the basis of the protective and regenerative action of high carbohydrate diets in liver necrosis caused by chloroform and phosphorus, in Eck Fistula dogs, in experimental cirrhosis of the liver, in obstructive jaundice, and in studies of metabolism of bile acids."

In 1936 Forbes and Neale found that an extract of the liver, or a suspension of sodium xanthine when injected into rats some hours before anesthetization with chloroform, protected the liver from injury. Later Fitz-Hugh and Barratt, MacLean and McHenry stated that such injections facilitated regeneration of the liver following injury. Data which Goldschmidt, Vars and I have obtained demonstrate that a liver high in lipid content and low in available protein is maximally susceptible to injury following chloroform anesthesia while a liver low in lipid content and high in available protein is maximally protected against injury. Even in the presence of a high concentration of liver lipid we found that a diet adequate in its protein content and administered for several days prior to anesthetization greatly reduced the incidence of necrosis of the liver.

It seemed to us that an adequate amount of a suitable protein in the dietary might be helpful from several points of view. First, certain of the proteins have been shown to be excellent lipotropic agents, and second, protein or some components of the protein molecule offers direct protection against chloroform necrosis even in the presence of high lipid concentrations. Our data point strongly to the fact that dietary carbohydrate is beneficial if, during glycogen deposition hepatic lipid is displaced and if the ingested or intravenously inject-

ed carbohydrate spares the protein stores of the liver. There is not the slightest evidence that glycogen directly protected the liver from this type of injury, nor to my knowledge has anyone ever published data which demonstrate how direct protection by glycogen can be accomplished.

We did not interpret the Forbes and Neale experiments as evidence of direct specific protection of sodium xanthine, but as evidence that protein split products resulting from the breakdown of protein in the body, made available substances which the liver could use in one way or another for protection. Our hypothesis was confirmed when we used sodium ricinoleate for the injection instead of sodium xanthine. Sodium ricinoleate sets up a better sterile abscess and leads to a greater breakdown of protein locally and in the body as a whole, and finally, it provides a greater degree of visceral protection.

Whipple and his co-workers have since confirmed our data showing that a diet adequate in protein will protect the liver from injury during chloroform necrosis and have extended these observations by demonstrating that a similar diet protects the liver from arsphenamine necrosis, while Smith has found that it protects the liver from selenium poisoning.

More recently Miller, Ross, and Whipple have stated that methionine, and to a lesser extent cystine, are the fractions of the protein molecule which provide this protection against chloroform. We have not been able fully to confirm these observations in rats and since our original observations on the protection afforded by protein and its split products were made on these animals we are not at all sure that the final answer has been provided in this matter.

About one-third of the patients coming to us with long-standing bile tract disease have abnormal accumulations of fat in the liver. Many of these patients have lower than normal concentrations of the plasma protein suggesting that protein synthesis is being interfered with or that there has been prolonged restriction of protein in the diet.

We have experimentally reproduced a somewhat similar condition by ligating the common duct and removing the gall bladder

from dogs which had previously been on a high fat-low protein diet. The purpose of the experiment was to determine the diet best suited to restore such a liver to a more normal composition in the shortest time. When high carbohydrate-low protein diets were compared to high carbohydrate-high protein diets, each in equivalent caloric intake, the high carbohydrate-high protein diet was twice as effectual as the diet containing a low protein intake.

Every patient operated on for gallstone disease does not develop liver necrosis regardless of the anesthetic used, but many of them develop minor or major degeneration of the liver. This may be characterized by a sharper post-operative reaction and occasionally, when extensive injury is present prior to operation, by a state of hepatic incompetency resulting even in death. Such reactions can in large part be prevented by a period of pre-operative therapy in which diet plays the most important role.

Some years ago Mann and Bollman published data which led many to believe that protein was harmful in the presence of liver injury in that ascites developed following its use, when in fact it is much more likely that the ascites which developed was the result of the administration of large amounts of the meat extracts which they unfortunately used as a source of protein. Using casein, Casec, or protein digests, we have not seen any increased tendency to ascites in the dog or man, and Whipple has had a similar experience using meat. It is a happy circumstance that nearly all workers in this field are now in accord that the carbohydrate-protein dietary is the one of choice.

It should be pointed out that the food intake should be in excess of the energy requirements of the patient if visceral storage is to be effected. This cannot now be accomplished by intravenous therapy, for it is impossible to provide even sufficient calories for the basal requirements by this method and the loss of weight of our patients is too often an expression of the extent to which we fail to meet their requirements.

If regeneration and repair of the liver are to be facilitated following injury, there must be provided a sufficient amount of an adequate protein in the diet following operation. Maximal regeneration and repair can never take place when the diet consists of foodstuffs from which cellular repair cannot easily take place. The problem here is analogous to the faulty wound healing which may occur during the hypoproteinemic state. The statement repeatedly made during the past twenty-five years that maximal repair of the liver will occur following the administration of a carbohydrate dietary violates the fundamental principles of cellular repair, for the regeneration that takes place under such circumstances must obtain its protein from endogenous sources.

Evidence which Vars, Schultz, and their co-workers are now obtaining in our laboratory suggests that the necessary protein may vary to a degree depending upon the specific type of cellular repair which is desired. Perhaps in the presence of liver injury, liver protein will prove to be much more beneficial than any other protein.

*Wound Healing.*—In 1934, Harvey in the discussion of a paper on "Wound Disruption" by Meleney and Howes stated, "There are constitutional alterations which may lead to weakening of the wound. In a young infant, badly nourished, with pyloric stenosis, for instance, the wound is not likely to heal well. In a patient with carcinoma of the stomach the wound is not likely to heal well. Senility per se has nothing to do with it, but with extreme malnutrition and anemia the wound will not heal well." In 1935 Smelo working in our laboratory on certain problems of wound healing concluded that "factors other than the local dressing appear to play the dominant role in determining the rate of wound healing."

That disruption is still encountered in wounds free from infection in which hemostasis was excellent, in which trauma to tissues and tension was minimal, and unusual strain obviated, and that healing may be delayed in wounds for which no local explanation can be found, strongly supports the concept that other factors of a general character often play an important part in the failure of certain wounds to heal.



We have shown that dogs which have been made hypoproteinemic and whose reserve stores of protein have been depleted by plasmaphereses and prolonged feeding of a low protein diet have a marked delay in fibroblastic proliferation. The hypoproteinemia in our dogs was but one easily measurable indication of protein starvation. We were inclined to attribute the delay in fibroblastic proliferation to the presence of edema and it very likely plays a part, but we believe that the mechanism is in large part associated with a profound disturbance in protein metabolism. Rhoads has recently shown that if the colloid osmotic pressure of the plasma of hypoproteinemic dogs is maintained with acacia, the tissues undergoing repair will utilize endogenous protein during wound repair.

Admont Clark showed that on a diet high in protein there was no quiescent period in the repair of wounds, and Harvey and Howes have reported that such a diet causes accelerated fibroblastic proliferation. Without adequate building stores repair cannot take place.

A protein deficiency is not the only biological mechanism responsible for wound disruption or faulty healing. Sokolov and Lanman and Ingalls have shown that a Vitamin C deficiency is also an important biological factor in the delayed healing of wounds. These two nutritional disturbances are frequently found in patients who come for operations for gastric ulcer and cancer, duodenal ulcer, and biliary tract disease. We have as a matter of interest found that the Sippy diet as used in our hospital is often deficient in vitamin C and that patients kept on such a diet may develop a vitamin C deficiency at a time when one is attempting to promote healing of the ulcer. It is important that such patients receive cevitamic acid during medical treatment and surely before and after operation.

When the delayed healing is associated to hypoproteinemia, the restoration of a normal plasma protein concentration and a more nearly normal store of tissue protein, the wounds promptly heal. Addis and his associates and Holman, Mahoney and Whipple have shown that plasma protein can be utilized to replenish the depleted

stores of tissue protein and it is this purpose we believe that the plasma protein which we have had to inject in excess of that estimated to restore a normal concentration in animals and patients fulfilled.

Hartzell, Winfield and Irvin and Rhoads have found hypoproteinemia to be more frequent in patients with wound disruption than is a vitamin C deficiency, and Munro has demonstrated the amazing healing which can take place in certain decubitus ulcers when nothing else is changed in the care of these patients except the addition of an adequate amount of protein to the diet.

When all the local factors favoring wound disruption or delayed wound healing are controlled, there will remain wounds whose failure to heal must be due to more widely acting causes such as a reduction in the protein stores of certain viscera and deficiencies in important accessory foodstuffs.

These are but a few of the nutritional problems which constantly confront us. Equally important ones exist in hyperthyroidism where we have found that an improvement in the nutritional state of the patient not only reduces the reaction following operation but results in a definite reduction in the mortality of the bad risk patients. Study of a large group of thyrotoxic patients convinces us that most of these individuals have a thiamin deficiency as well as a deficiency in other components of the B complex. Such a deficiency is no doubt the major factor in the loss of appetite and the resulting loss of weight which these patients suffer. Many of the cardinal symptoms of hyperthyroidism are likewise the symptoms of a B complex deficiency.

A better understanding of these and many other problems of nutrition, which are constantly present in many surgical patients, and the correction of them cannot help but lead to a further reduction in the morbidity and mortality of anesthesia and operation in a wide variety of conditions.

Little further can be expected in reducing the mortality of surgical operations by changing the types of incision, or the types of suture, but a great deal can be expected by a more comprehensive study of the problems presented by the individual patient in his reaction to disease or injury. A new

era of physiological surgery is at hand for both the civilian and military surgeon and he who fails to realize it will remain an operator whose morbidity and mortality will exceed those of his more enlightened colleagues, however brilliant his technical skill may be.

In the past the nutritional state of the individual has been considered to bear some relationship to general resistance. I hope that I have shown you that the part which it plays is much more important than this and further that I have awakened your interest in an important aspect of surgery.

## THE PLACE OF THE ANAESTHETIST IN THE SURGICAL TEAM

by *Lt.-Col. V. GOLDMAN—R.A.M.C.*

Mr. President, Ladies and Gentlemen,

It is a great honour to be invited to address this, the first, gathering of Surgeons in Lahore and I thank you for the compliment that such an invitation pays to the present status of the anaesthetist. Following immediately upon the President's admirable and far seeing address I must say that I feel a little akin to the naughty schoolboy who was asked to address a Headmasters' Conference. Anaesthesia has become a science as well as an art and the achievements of the past 25 years have made possible surgical procedures hitherto considered impossible. Anaesthesia for chest surgery, for which we owe so much to Magill; the absorption technique in which Waters of Madison was a pioneer; and the adoption of balanced anaesthesia, an advance advocated so strongly by Lundy of the Mayo Clinic, are developments as outstanding as many advances in surgery and without them the hazards of many modern operations would be greatly increased. Modern methods have meant a great increase in the patient's comfort; gone are the days of stifling inductions with masks and hours of sleeplessness and vomiting after the operation.

The anaesthetist is a technician, a doctor and a physiologist who practices toxicology. He acts as a trustee and is there to guarantee the patient's interests. He should decide—in consultation with the Surgeon—on the best approach to the surgical problem involved. He should care for his patient's welfare before, during and immediately after the operation for he holds the patient's life in his hands and should return

him to the ward after an operation in a condition as fit as possible so that his convalescence will be uneventful and the possibility of complications reduced to a minimum.

In the ideal state of things the anaesthetist should have very well defined duties and these should embrace very much more than dropping chloroform on a mask at the Surgeon's dictation. In the first place the anaesthetist should be responsible for ensuring that before the operation the patient is in as fit a condition as possible and that his outlook towards the coming ordeal is a cheerful one. Steps should be taken to see that his worries and anxieties are relieved and that he has a restful sleep the night before the operation. Every patient should be visited by the anaesthetist at least once before the operation. The oro-dental hygiene noted, the presence or absence of accessible veins elicited and any physical abnormalities memorised. In addition any X-ray or laboratory reports should be carefully examined and if the anaesthetist feels that additional investigations are necessary these should be initiated. In serious cases it should be the anaesthetist's duty to make certain that whole blood, serum or saline is available so that no delay may occur if it is necessary to use such means of resuscitation during the operation. It must also be remembered that in some cases it is advantageous for a pint or more of whole blood to be given to the patient a day or more before operation and it is the anaesthetist's duty to advise on the necessity for this step if he feels that such a procedure would benefit the patient. In cardiac cases the anaesthetist's advice is essential—the physician can only tell the Surgeon the

nature of the lesion—but an anaesthetist from his own experience should be able to evaluate the risk in any particular case and also recommend the safest form of anaesthesia for the operation contemplated. In lung surgery the anaesthetist naturally comes into his own, for if the Surgeon invades the anaesthetist's own territory and the respiratory system is the anaesthetist's domain, he must accede to his wishes. In some cases the anaesthetist may be called upon to advise a preliminary artificial pneumothorax; in others he may have to advise against operation altogether.

The choice of anaesthetic must not be an empirical one, the patient's wishes, the Surgeon's preferences, the anaesthetist's skill and above all the safety of the patient are factors that must be considered in every case. The anaesthetist's responsibility does not cease when the last stitch is tied. He is responsible for the safe removal of the patient to his bed and for the patency of his airway. If he is unable to keep the patient in the theatre until his reflexes have returned or if he cannot return to the ward with the patient himself, it is his duty to ensure that the nurse who does go with the patient is properly trained in post-operative care and realises the dangers of an obstructed airway. The anaesthetist should also supervise the care of the patient for the first 24 hours after the anaesthetic—except as far as surgical complications are concerned—and should make certain that adequate precautions are adopted to prevent post-operative chest complications. He should visit his patient so that the treatment of such complications can be adopted without delay. Regular visits to the patient after operation will enable the anaesthetist to evaluate differing anaesthetic techniques and will help him to assess the relative post-operative comfort following each type of anaesthetic employed.

The anaesthetist must keep all his equipment in order and ready for use and should, of course, ensure that an adequate supply of the necessary drugs, syringes, needles, etc., are always available. The keeping of records taken during operations and including a post-operative "follow-up" will be of extreme value to Anaesthetist and Surgeon alike. There are other directions too in

which an anaesthetist can be of extreme value to the Surgical Team. Diagnostic lumbar punctures are best done by such a person for the busy anaesthetist has very much more practice in tapping the cerebro-spinal fluid than the Surgeon or the Physician. Oxygen therapy is a line of treatment in which it is obvious that the anaesthetist should be the most experienced person to direct such work. His opinion should be consulted in the choice of apparatus and in the type of case for which such treatment would be beneficial.

The Blood Transfusion Service of a Hospital should have a very close liason with the Anaesthetist—in fact in some American Clinics the Anaesthetist is entitled "Anaesthetist and Blood Transfusionist." There is good reason for this choice for the anaesthetist should be the person to decide on the amount of resuscitation necessary before the serious case is fit for anaesthesia, and during operation he is again called upon to take the responsibility of deciding if and when intravenous therapy is necessary. Usually, too, he is the most experienced officer in finding veins! Certain diagnostic and other procedures are best relegated to the anaesthetist, these include diagnostic spinals and paravertebral blocks as well as infiltrations of a local anaesthetic agent for the relief of pain.

I know that my next point will be a controversial one but I mention this only after careful thought and considerable experience I feel that the anaesthetist should actually be responsible for the Operating Theatre routine—by that I mean that he should supervise the arranging of lists and the maintenance of all equipment. In most Hospitals it would be found a convenience if the upkeep and repair of apparatus were under the control of one man, and who could be better for this undesirable duty than the anaesthetist? He is blamed for most things so here is another chance to pass the baby! However, joking apart, this is really a most desirable innovation for the anaesthetist works for a number of Surgeons and is thus able to know their requirements.

The most important duty of the Anaesthetist after that of giving anaesthetics is that of instruction whether he be attached

to a teaching Hospital or not. It is his responsibility in every hospital to see that the junior medical officers and the nursing staff are correctly taught the principles which underlie the pre-operative and post-operative care of patients. In addition, however small the hospital may be, he should endeavour to instruct at least one member of the Staff to give simple but safe anaesthetics as he himself may not always be available. In a teaching establishment he must be responsible for making certain that every student who qualifies can give an anaesthetic to a patient in an emergency. Now that anaesthesia has become a more important subject, its teaching must be revised and the minimum requirements of the qualifying boards increased to modern standards. At least 12 lectures on the subject should be necessary and a month's special clerking be decreed essential. In addition during the physiology course special attention should be given to its application to anaesthesia, and I am of the opinion that one or two of the lectures should be given by the anaesthetist. In order to focus the attention of all medical students to the value of at least a basic knowledge of the subject, apart from increasing the necessary lectures and attendances, at least one question in the final surgery examination should have an anaesthetic reference and in the oral an anaesthetist should be present to ask each candidate one question on elementary anaesthesia or the use of a simple piece of anaesthetic equipment. In this way it will be generally realised that anaesthesia is an essential part of surgery.

When the interest of students and post-graduates has been sufficiently aroused, each Medical College should then initiate a higher examination in which the standard should be as high as the Master of Surgery. I consider that this higher qualification should not be termed a "diploma"—Universities award degrees—it could very well be called Master of Surgery (Anaesthetics), in fact such a degree already exists in a few American Universities.

In the administration of the Hospital the Anaesthetist should have an equal voice on the Medical Committee with the other members of the Hospital Staff. If it is desired to get the best out of a colleague

he must have equal rights—that is the principle of democracy. This concession will reap an ample reward for the anaesthetist is usually quite an intelligent fellow and his opinion may be found to be quite useful. And talking of equal rights we are brought face to face with the biggest problem before us and the one that needs settling without delay in this Country; that is the question of the financial aspect of anaesthesia. In order to attract the best post-graduates it must be made possible for the good anaesthetist to earn as much in the aggregate as a surgeon or physician. He must be able to take his place in the scheme of things in just the same way, he must pay frequent visits to clinics in other parts of the World and he can only do this if his position is assured. The Army has done a great deal to raise the status of the Anaesthetist by giving him rank and pay equal to that of other specialists, and this must be made to apply to civil practice as well. It does not matter if the anaesthetist works in a full time service or privately, he must have an equal reward for his years of study, otherwise the best students will not be attracted to this speciality. In the anaesthetic market as in everything else you will only get the anaesthetics you pay for; sixteen rupees will not get the services of an expert who has to travel the World to keep abreast of the times!

I have tried to draw attention to the many ways in which an anaesthetist can become an integral part of the Surgical Team and also how the best people can be attracted to the speciality. I would stress the fact that a properly run anaesthetic department would greatly assist the Surgeon and would remove many of his anxieties. The anaesthetist is a willing and faithful servant and if taken into the Surgeon's confidence will prove a most valuable partner.

In my ideal scheme there would be an anaesthetic department in every large hospital. The senior anaesthetist would act as Director and have at least one assistant and one resident solely employed on anaesthetic duties. In addition there would be a Sister-Secretary whose duties would include the supervision of records, the preparation of equipment and solutions and generally assisting in the Theatres as required. Also

in my ideal scheme all the anaesthetics would be given by an anaesthetist—spinals and locals should be as much his responsibility as an open ether. The Surgeon is not able to devote his undivided attention to his work if he has to keep one eye on the patient as well. That sort of thing is all very well on board ship or on a desert island but not in a modern hospital. The Surgeon's responsibilities are great, his hours long and his duties arduous. The wear and tear on his whole system would be much less if he could share these things with a trained colleague who could do so much to make his work lighter and his operation days run smoothly. After all the less time that the Surgeon has to spend in the operating theatre the better is the work that is done and it should be an important duty of an anaesthetist to see that his Surgeon is not delayed nor interrupted while doing his delicate work by outside matters. He should be the buffer that takes all the shocks and it should be his aim, as well as giving anaesthetics, to act as the Surgeon's bodyguard. There are a thousand and one little details that crop up during a heavy day's operating that can be settled by an intelligent anaesthetist. A new sister can be told about the Surgeon's preferences in ligatures and instruments; an eye can be kept upon the temperature of the theatre; the nursing staff can be warned about the position required for the next operation. In fact an anaesthetist can make himself indispensable, so much so that his surgeon should feel lost and find it difficult to carry on without him.

Such then is the place of the anaesthetist in the surgical team and if I have helped in a small way to create a desire for the employment of competent anaesthetists in this Country I shall be indeed happy. The next advance would be the establishment of an All India Association of Anaesthetists, but that will have to come later when there are more medical men engaged in the speciality.

To summarise then the anaesthetist should advise the surgeon on the fitness of the patient for operation, he should suggest any pre-operative treatment that he may deem necessary before the operation, he is solely responsible for the patient's condition during the operation thus allowing the Surgeon to concentrate on his own job and he should keep careful records of blood-pressure, pulse and respiratory rates, noting steps of the operation, the patient's condition and any change in the anaesthetic technique. After operation he must still be responsible for the patient's condition, for until the patient has completely recovered from the anaesthetic, and all risk of post-anaesthetic complications is past, he is the member of the surgical team best fitted to suggest any treatment that may be necessary. In addition he should complete his records by noting details as to complications and the speed of recovery. These records will be of extreme value both to Surgeon and Anaesthetist for hard facts are more convincing than mere fantasy!

It has also been suggested that the anaesthetist can be useful to the surgical team on account of his specialised knowledge and experience in certain diagnostic procedures and he should advise on oxygen therapy and resuscitation. Not the least of his duties should be to act as the surgeon's aide-de-camp, by arranging that the work should run smoothly and that the theatre as a whole should be able to cope with all emergencies without a hitch.

I thank you for listening so patiently to my dream of an Anaesthetist's paradise where the Surgeon and the Anaesthetist would be equal partners, united for the benefit of the patient and the advancement of surgical knowledge. In that way surgery in this Country will take its rightful place and the advances in anaesthetic technique that have emanated from the rest of the World will become available to all those who live in this vast land.

## PROGNOSIS IN CANCER OF THE FEMALE BREAST

by V. R. KHANOLKAR—Bombay.

When a patient presents herself with a cancer of the breast one of the problems which confronts the examining physician is a forecast of the probable course of disease. The clinical examination and the diagnosis give an indication of the general progress of the malady. Statistical reports afford information regarding the cure or survival rate. The patient however is not interested in general statements. The fact that 40% of people with breast cancer survive for a period of five years with modern treatment appears to her irrelevant. She wants to know the expectation in her particular case. This is usually a difficult matter to decide and has to be based both on a knowledge of the individual and an understanding of the disease. The age of the patient, her general health, her resilience, and the nature and extent of the disease determine the prognosis. Further, a more detailed study of prognosis in breast cancer is necessary because a rational line of treatment could only be planned when one is conversant with the direction of the likely spread of the disease. A patient expects to be told the reason for submitting to a major operative procedure for perhaps a painless condition, and likes to know her chances of complete recovery or partial restitution if she submits to the suggested course of treatment. A physician who is cognisant of the turn of events in any particular case is prepared with effective measures to ward off unpleasant complications, as well as to shield his patient from procedures which may adversely affect her.

The following review is based on a perusal of available literature, as well as on a study of 240 cases of breast cancer admitted to the Tata Memorial Hospital during the last four years and in whom the biopsied material or the operative specimen was available for a careful histological examination.

Carcinoma of the breast results from an atypical growth of the epithelial lining of the ducts, the canaliculi or the acini in the mammary gland. The reactive and mechanical resistance of the walls of these struc-

tures tends to restrict the infiltrative tendency of neoplastic cells for some time in several cases (9). The outcome is much more favourable before the actual break through in the tissue spaces, than after the involvement of extra glandular tissues. The extent and the rapidity of the spread depends on the invasive character of the tumour cells in any particular case. The aim of the clinician is therefore to determine the extent of the tumour spread and of the pathologist the degree of malignancy of the tumour cells. The clinician judges the extent of the spread by his findings on physical examination. The hopes of a cure by any treatment are considered negligible if the patient presents certain physical signs and the case becomes unsuitable for a curative surgical procedure. Haagensen and Stout (5, 6) have stated the following criteria for judging the inoperability of breast cancer cases even though their general condition may be good enough to withstand a radical operation.

1. When the carcinoma is one which developed during pregnancy or lactation.
2. When extensive edema of the skin over the breast is present.
3. When satellite nodules are present in the skin over the breast.
4. When intercostal or parasternal tumour nodules are present.
5. When there is edema of the arm.
6. When proved supraclavicular metastases are present.
7. When the carcinoma is of the inflammatory type.
8. When distant metastases are demonstrated.
9. When any two, or more, of the following signs of locally advanced carcinoma are present:
  - (a) Ulceration of the skin.
  - (b) Edema of the skin of limited extent (less than one-third of

the skin over the breast is involved).

- (c) Fixation of the tumour to the chest wall.
- (d) Axillary lymph nodes measuring 2.5 cms. or more, in transverse diameter, and proved to contain metastases by biopsy.
- (e) Fixation of axillary lymph nodes to the skin or the deep structures of the axilla, and proved to contain metastases by biopsy.

It is unnecessary to discuss the prognosis in many of the breast cancer cases who come to our clinics. When a woman sees us with a deep foul smelling, fungating mass with axillary and supraclavicular glands which are involved in the process, no surgical or other procedure that we know is going to cure the disease. Much can be done by way of palliation, but the chances of the person surviving for five years are negligible. It is therefore necessary to deal with cases not so far advanced and to restrict oneself to only two clinical features, involvement of the axillary glands and localised edema of the skin. These two signs should be looked for very carefully in every case as they materially alter the prognosis even in relatively early cases.

The metastatic involvement of the axilla in cancer of the breast is a very important event, probably the *most important*, in the spread of the disease. The physician should endeavour to diagnose the disease before an evidence of this supervention and should avoid all manipulations which would favour its occurrence. A well-to-do person in our country gets the worst deal as regards treatment of cancer. The reason for this statement which may appear extreme is based on the fact that she is taken from doctor to doctor and every examination increases her chances of metastatic scattering of tumour cells. The probability of a five-year cure after radical operation without axillary involvement is 70%. After an appearance of a clinically palpable node with the same operative procedure the five-year cure rate is 20% and after simple mas-

tectomy 0%. Figs. 1 and 2 are based on data collected by Simmons (10, 12, 13) from the records of two large hospitals in Boston. Fig. 1 shows the 10 year survival rate in

COMPARISON OF LIFE EXPECTATION BETWEEN NORMAL

WOMEN AND WOMEN WITH CANCER BREAST

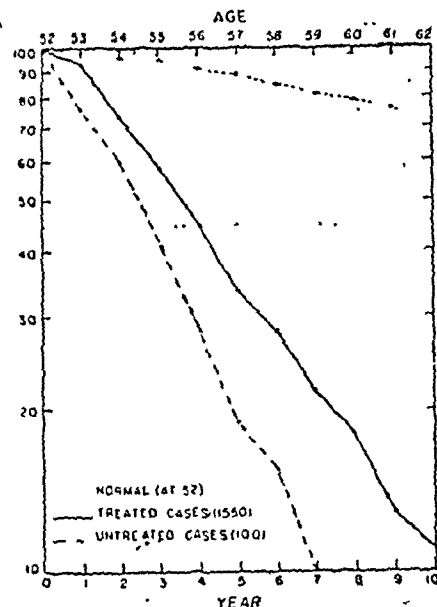


Fig. 1.

women 52 years old, and those with breast cancer treated and untreated by modern methods. It would be seen that out of every 100 women commencing at the age of 52 only about 72 reach the age of 62. No woman survives for 10 years with an inefficiently treated mammary cancer, though 18 out of a 100 would still be alive with the disease at the end of five years. These data should afford a basis for an evaluation of any type of treatment that may be advocated for this disease. Fig. 2 shows that the survival rate for breast cancer cases without involvement of axilla is almost identical with that which may be expected in a normal population of women 52 years old. On the other hand, the survival rate after the involvement of axilla is only about 33 at the end of five years and only about 22 at the end of ten years.

The important fact however is not the clinical palpability of the axillary nodes as their microscopic invasion. Careful study of operated specimens has shown that 40% of the breast cancers which were clinically considered free from axillary metastases showed microscopic deposits; and 30% of supposedly cancerous glands did not reveal tumour cells in them. On the other hand even one hard node larger than 2 cms. in transverse diameter implies a metastatic involvement by cancerous process.

## SURVIVAL RATE IN BREAST CANCER

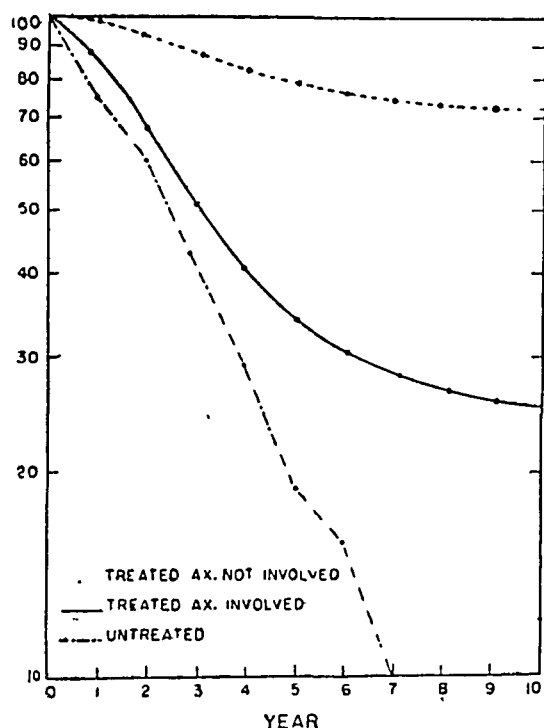


Fig. 2.

A localised edema of the skin over the breast is a clinical finding of great significance. It should be looked for carefully in every case particularly in the dependant part of the breast near the areola, or over the tumour. This statement does not refer to the extensive edema in the inflammatory carcinoma of the breast or the orange peel skin, nor the edema of the supraclavicular fossa and the upper arm. In such cases the disease is much too advanced and the prognosis is hopeless. It is intended to particularly refer to a localised area of edema

which easily escapes attention and which has an interesting pathological bearing. The cancer cells after breaking through their initial enclosures infiltrate into the main lymphatic pathways which accompany the ducts as they converge towards the nipple. The lymphatics in the breast originate in tissue spaces which open into an intricate basket work of lymph capillaries round the glandular clusters in the periacinar connective tissue. They drain into lymphatics which run along the canaliculi to form larger channels along the ducts. Lymphatics also accompany the blood vessels and communicate with those around the lobules and the ducts. In the tissue underlying the areola of the nipple there is a rich coarse-meshed network of wide lymphatics (subareolar lymphatic plexus of Sappey). The papillary and deep lymphatics of the skin, the lymphatics along the walls of the lactiferous ducts in the nipple, as well as those from the body of the breast drain freely in this subareolar plexus. The efferent lymph vessels emerge from it to traverse the mammary tissue and drain in the lymphatics which lie in the fascia of the Pectoralis major muscle. The proliferating cancer cells sooner or later break out from the walls of epithelial structures and infiltrate into the surrounding tissue spaces. The cancer cells are carried as embolic masses in the deep network of lymphatics in the corium. The superficial and deep lymphatic networks of the skin get solidly choked with tumour cells and edema of the neighbouring skin, particularly of the dependent portion supervenes. Edema of the skin even of a very restricted area has therefore a serious prognostic significance because it implies an embolic and extensive involvement of subcutaneous tissue by cancer cells. It has been found that the five-year cure rate with this physical sign alone is 12.5% and associated with any other signs of locally advanced disease is 0%.

Several attempts have been made to determine the type of malignancy of breast cancer on the clinical findings. An index suggested by Lee (7) is shown in Table I. The weighing factor is multiplied with the gradation factor and the sum of indices so obtained is computed to gauge the relative malignancy of the tumour.



TABLE I

Weighing Factor		Gradation Factors	
Age	A 2	Over 55	1
		41-55	2
		40 and under	3
Lactation	L 3	Absent	0
		Present	3
Rate of Growth	R 4	Slow	1
		Moderate	2
		Rapid	4
Extent of Disease	E 5	Small (3 cms. or less)	1
		Large	2
		Nodes present	4

Grade	Score	Prognosis	5 year cures
A	11-25	Relatively Benign	69%
B	26-39	Moderately Malignant	34%
C	40-55	Highly Malignant	4%-17%

The degree of malignancy of a cancer is determined by the character of the cells composing it. These characters may vary considerably in different tumours, but there is usually a remarkable similarity in detail in the different areas of the same cancer. The pathological features which affect the prognosis are therefore sought in the histological appearances and by correlating them with the survival rate of the patients. The microscopic appearances are noted and expressed by typing them in three or four grades. A grade III or IV cancer being assumed to be more malignant than a grade II or I type of tumour. The clinicians lately have become enamoured of this facile classification of tumours and expect to find in it an easy answer to their hesitations. A careful study of histological material during the last four years has however convinced us that no histological character has anywhere nearly the same prognostic-value as the two clinical findings which were described above. This is evident from the data collected by Frantz (3) from the records of the Presbyterian Hospital, New York, on the basis of 130 operable cases (Fig. 3). It is seen that the involvement of the axilla is of a relatively greater prognostic signi-

ficance than a histological grading of tumours. It is however found that the anaplastic types of cancer (grades III and

## SURVIVAL RATE IN BREAST CANCER

ACCORDING TO GRADE WITH AND WITHOUT

AXILLARY METASTASES

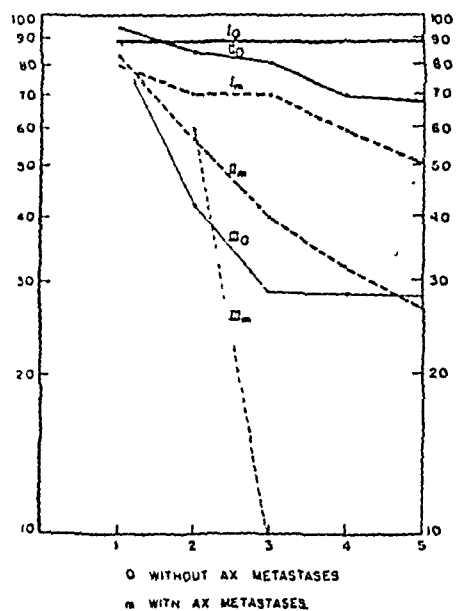


Fig. 3.

IV) grow more rapidly, and are more radiosensitive than the differentiated types grades I and II. This radiosensitivity should not be confused with radiocurability and it should be realised that the prognosis for patients with anaplastic cancer is invariably poor.

The pathologist discovers the essential characters of a cancerous process in the presence of atypical cells. It may therefore be worth while to describe the atypical qualities which are utilised in judging the degree of malignancy. The most important characters are four. They are: -a loss of polarity, anaplasia, accelerated and unequal growth; and finally heterotopia (1). The cells composing any organ or tissue pass through two distinct stages, the period of growth or proliferation and that of cell differentiation. The features which impress the histological peculiarities on the cells of any particular tissue are acquired during

the process of differentiation. MacCarty (8) analysed the process of tissue differentiation into three recognisable stages as follows:

1. The establishment of the general alignment of the cells which is shown in the normal arrangement of adult tissue.
2. The establishment of cellular polarity, and
3. The establishment of the adult morphology of cells.

In the differentiated condition and in the first two stages the cells bear hardly any resemblance to the adult form. The fixed cells in the tissues acquire a definite orientation or polarity during the course of tissue differentiation. They are arranged in a particular manner in relation to their base and to their neighbours. This arrangement remains more or less constant throughout the life of the individual and enables a histologist to recognise a tissue by the configuration of the constituent cells. When the cells lose their polarity they lose their grouping and become detached from their usual surroundings. They become heaped up in a disorderly manner. We might designate this characteristic as a topsy-turvyness of the tumour cells. Experience has shown that malignant cells which retain their polarity are much less dangerous than those which lose it.

The next consideration is anaplasia. It reveals itself by certain histological characters. These consist of a variation in the size of cells and of their nuclei. The nuclear membrane becomes more distinct, the chromatin more condensed, the nucleoli more prominent. We describe this appearance by stating that the nuclei are hyperchromatic. The feature however is the huddling together of big and small nuclei with a remarkable variation in the size and shape, and without any conceivable arrangement. The size of the cells does not seem to have any decided effect on the malignancy of the tumour, except that recently Paletta and Lehman (11) have observed that 60% of tumours with bone metastasis consisted of predominantly small cells and the visceral metastasis of large cells.

The rate of acceleration of growth is usually shown by the number of mitoses in active fields of tumour tissue. The mitoses are often atypical, unequal and multipolar and it is believed that the more unequal the cell division the greater will be the degree of anaplasia in the progeny.

The heterotopia or out of placeness is shown by a distortion of the outline of the canaliculi and later by an escape of tumour cells outside the walls of the ducts and the acini. This is followed by an infiltration of cancer cells into connective tissue spaces and by an invasion of lymphatic and venous channels. The loosening of the cells from solid blocks and their transport as cell emboli in lymph and blood vessels are extreme examples of heterotopia and are the most dangerous events in the progress of disease. It is now realised that mechanical trauma is an important factor in the extension of tumours. Palpation of all glandular tumours should therefore be practised as carefully and as little as possible.

There are many other features which the histologists study in detail. They help to confound the clinicians and confuse the pathologists. None of them have much effect on the prognosis of the disease. A tentative scheme for the histological grading of breast tumours is suggested in Table II on the basis of the general ideas outlined above.

TABLE II

	Weighting Factor	Grading Factors
<i>Character of Cells (Add):</i>		
Size	1	Large 1 Small 2
Hyperchromatism	2	Moderate 1 Marked 2
Mitosis	3	Scarce 1 Moderate 2 Many 3
Variability	4	Slight 1 Moderate 2 Marked 3
<i>Character of growth (Deduct):</i>		
Intracystic Papillary	...	Marked 3
Adenoid Structure	...	Moderate 2 Slight 1
Gelatinous degeneration	...	1

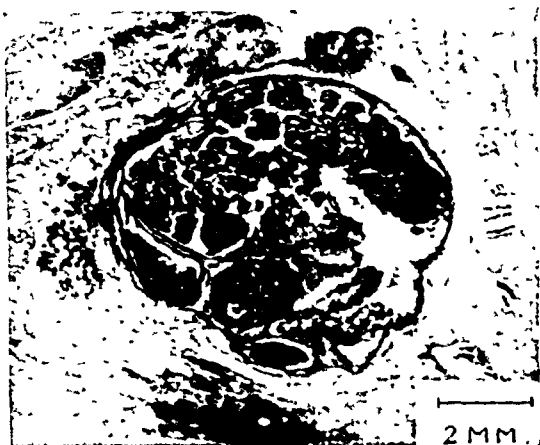


Fig. 4.

A photomicrograph of a small papillary cystadenoma of the breast (diameter 1 cm.) in a 57 year old woman (8583). In the portion enclosed in a circle early proliferative changes are seen. The proliferated cells are still limited within their normal enclosures, a condition described as Carcinoma in Situ by Foot and Stewart (2).



Fig. 5.

A low power photomicrograph of the portion inset in Fig. 4. The lesion is evidently Carcinoma grade I.

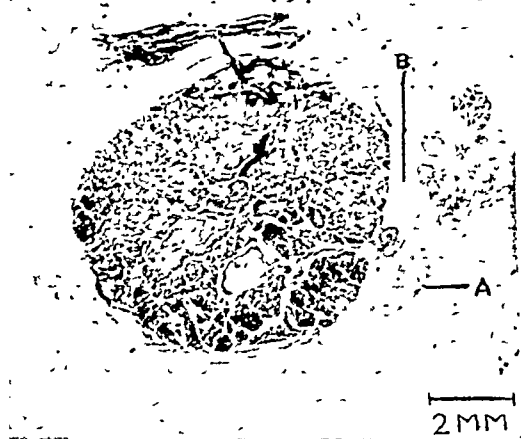


Fig. 6.

A photomicrograph of a papilliferous cystadenoma (diameter 3 cms.) in a woman 57 years old (3351). In the wall of the cyst at a portion marked A, a small opaque hard nodule (diameter 2 mm.) was discovered (inset A). Extending from this nodule was seen a slightly greyish firm area (inset B). History of one month's duration.

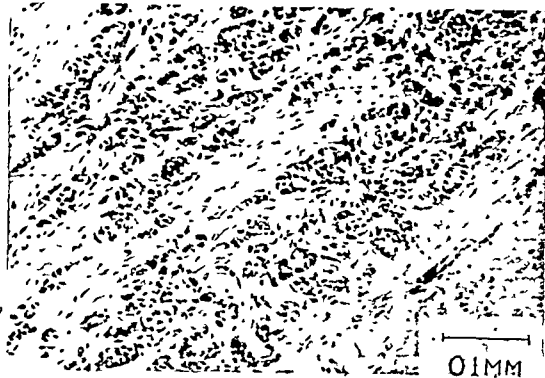


Fig. 7

A low power photomicrograph of the portion enclosed in inset B. It is a typical Carcinoma of the Breast grade II. The tumour recurred within 15 months after local excision and a radiation therapy consisting of 1600 roentgens at 200 Kv from each of two fields. Second recurrence after excision, within a further period of 7 months.



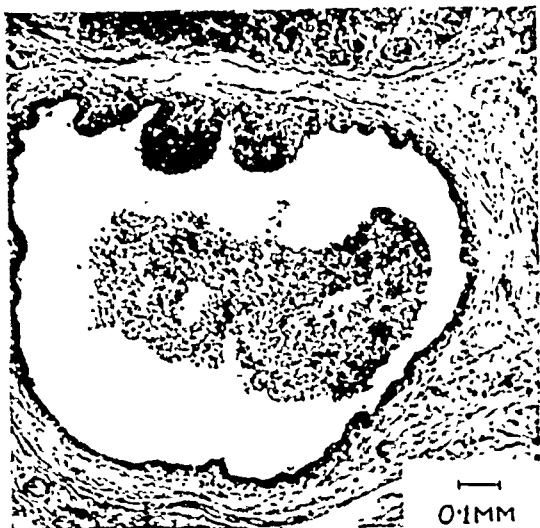


Fig. 8.

A tumour of the breast in a 36 year old woman ( 8091). A history of 3 month's duration shows knob like proliferative epithelial nodules in the wall of a dilated canalicule. The proliferating cells are seen infiltrating into the pericanalicular tissue near the extreme upper end of the figure. Carcinoma grade II.

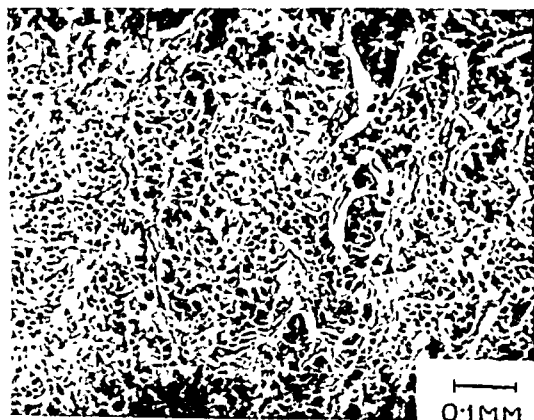


Fig. 9.

A carcinoma of the left breast in a 50 year old woman ( 7373) shows sheets of polygonal cells with definite variation in the size and shape of nuclei, hyperchromatism and moderate mitosis. Carcinoma grade III.

Fig. 12.

A similar tumour to the one shown in Fig. 11, in a 28 year old woman ( 8793) with 4 month's history, rapid growth, slight adenoid structure, gelatinous degeneration, moderate variability and mitosis. Carcinoma grade II.

The last two specimens are shown to illustrate the differences in tumours resembling each other in gross appearance but having different prognosis.

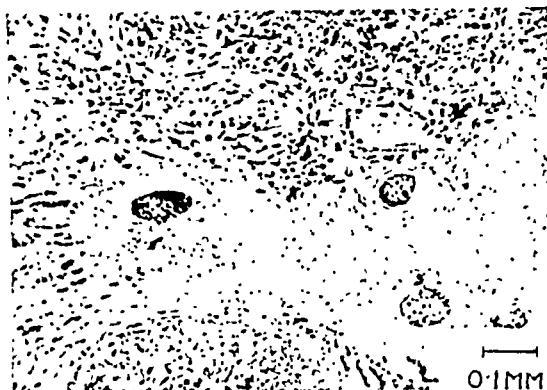


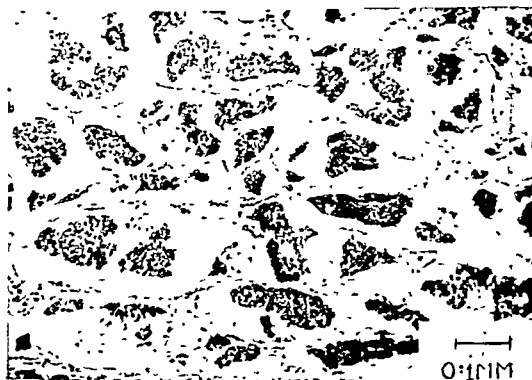
Fig. 10

A rapidly growing diffuse carcinoma of the right breast in a 33 year old woman ( 7808) with emboli in dilated lymph vessels and marked anaplasia of cells. Carcinoma grade IV.



Fig. 11.

Cancer of the right breast in a 53 year old woman ( 8826) with a history of a lump in the breast for 5 years showing marked adenoid structure and gelatinous degeneration. Carcinoma grade I.





Grade	Score	Prognosis
1	1-10	Relatively Benign
2	11-15	Moderately Malignant
3	16-20	Malignant
4	21 and over	Highly Malignant

It has to be admitted that the above scheme can only furnish a rough index of the degree of malignancy of the tumour, and should not be accepted irrespective of the clinical findings which have been referred to. The local considerations which have a bearing on the prognosis of mammary cancer may also be summarised as under.

1. Involvement of the Axilla :
  - (a) Situation, size and number of involved lymph nodes.
  - (b) Fixation of enlarged nodes to chest walls.
2. Blockage of Cutaneous lymphatics by cells :
  - (a) Localised area of oedema.
  - (b) Peau d'orange.
  - (c) Edema of supraclavicular fossa and the arm.
  - (d) Discrete skin metastasis.
3. Histological characteristics of the Tumour :
  - (a) Manner of Growth :
    - (i) Intramural Localisation :
      - Cancer in situ
      - Intra-epithelial growth
      - Comedo carcinoma (cribriform arrangement)
      - Papillary intra-cystic carcinoma.
    - (ii) Adenoid arrangement of cells.
    - (iii) Invasive or infiltrative growth.
    - (iv) Emboli in larger vessels.
  - (b) Character of tumour cells :
    - (i) Variation in size and shape of nuclei.
    - (ii) Number of mitosis.
    - (iii) Hyperchromatism.
  - (c) Gelatinous Degeneration.

## ACKNOWLEDGEMENT

I am indebted to my surgical colleagues for many thought-provoking discussions on the subject and to Dr. M. V. Sirsat for assistance in the study of the histological material.

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# FROZEN SECTIONS FOR THE DIAGNOSIS OF TUMOUR OF THE BREAST

by M. V. SIRSAT—Bombay.

## INTRODUCTION

The importance of early diagnosis of Cancer of the breast is generally recognised and anything which would establish a correct diagnosis is welcome. As a result of this, the frozen section method was eagerly seized upon because the diagnosis could be made while the patient was on the operation table.

Welsh is given the credit of having made the first frozen section in 1891, though Wilson, McCarty and Bloodgood have been largely responsible for its development since that time.

There are no clinical features that are pathognomic of diagnosis of early cancer of the breast. The prognosis and the ultimate survival time largely depends on the diagnosis of cancer of the breast before the metastatic involvement of the axillary glands. The following figures from different institutions in America will bring out this point clearly.

### RESULTS IN BREAST CANCER WITH OR WITHOUT REGIONAL LYMPH NODE INVOLVEMENT

Author: Clinic: Date of Publication	With lymph node metastasis	Without lymph node metastasis
Halington: Mayo Clinic 1933	20.3% alive 5 years 14.6% alive 10 years 10.5% alive 15 years	71.2% alive 5 years 52.9% alive 10 years 40.7% alive 15 years
Simmons, Taylor and Adams: Massachusetts General Hospital 1936	25 (25% of 101 patients) Living 5 to 7 years	44 (74.8% of 58 patients) Living 5 to 7 years
Lee: B. J. Memo- rial Hospital 1933	23% (of 103 patients) alive for 5 years	72% (of 217 patients) alive 5 years
Mathews, F. W. St. Luke's Hos- pital, New York City 1933	9 or 11.7% of 77 patients alive 10 years or more	19 or 57.5% of 33 patients alive 10 years

It will be seen from this how important it is to make an early diagnosis of cancer of the breast. Frozen section is thus a valuable means to achieve this.

It must however, be recognised that there are certain hazards in the frozen section method of rapid tissue diagnosis. Frequently the surgeon excises a single piece of tissue which appears to him to contain the suspected lesion but the pathologist finds no evidence of carcinoma in the small excised piece. It may then be assumed that cancer is not present whereas a careful examination of many permanent sections will often reveal the presence of cancer in other areas.

The routine of the frozen section followed at Tata Memorial Hospital is as follows. Surgeons at this Institute when they need the assistance of the Pathologist for microscopic examination of the section at the time of operation, excise the whole tumour-bearing area. The incision taken for this purpose is right on the tumour and the whole tumour-bearing area is excised, care being taken not to cut into the tissue at any stage of this procedure. This prevents dissemination of malignant cells in those cases where the tumour proves to be a malignant one. Besides, the excision of the whole tumour helps the pathologist to make a thorough gross study of the specimen. It takes, on an average, ten minutes to cut and stain a good frozen section and report on it. Surgeons all express spontaneous willingness for the pathologist to take his time during the cutting of the frozen section in order to enable him to do his work well.

## TECHNIQUE OF FROZEN SECTION

A representative piece of tissue from which frozen sections are to be cut, should not be thicker than 3 mm. The tissue is placed in 10% Formol Alcohol. The fixative should be 20 times the volume of the tissue. The test tube containing this should be kept in a water bath for 2-3 minutes. The tissue is then placed on the freezing box and sections are cut usually 10-20 "





Fig. 1.



Fig. 2.

Plasma Cell Mastitis

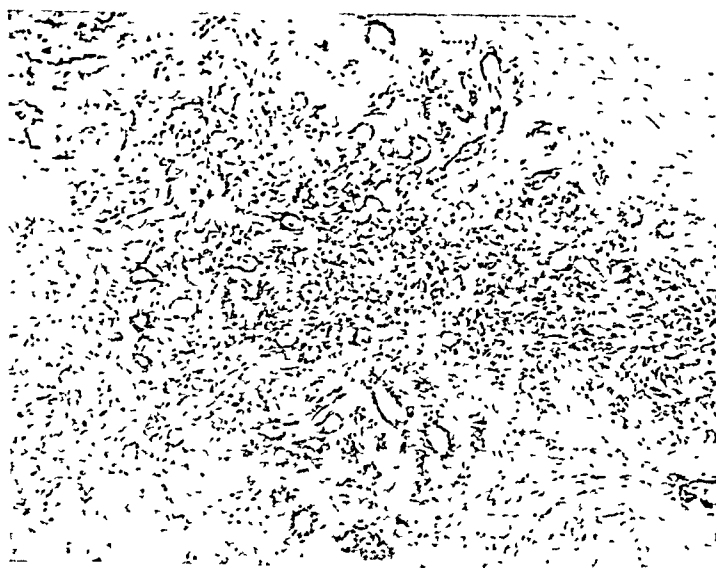


Fig. 3.

Fibrosing Adenomatosis



in thickness. A number of sections should be cut in quick succession. They are placed as cut, in a large size petri-dish containing water. The sections are passed through 40% alcohol and are then floated on to a slide and spread out evenly. The section is carefully covered with rectified spirit. After 30 seconds the spirit is drawn off the section and blotted with fine filter paper. The sections are then stained with Hematoxylin and Eosin. A good differentiation of a section is an essential condition for a quick and accurate diagnosis of a lesion.

During the year 1943, twenty five tumour cases of breast were examined by the frozen section method.

The average age in these 25 patients was 40.5 years. It is in this age group that the clinician looks most seriously to the problem of deciding between malignancy on the one hand and an undesirability of sacrificing tissue unnecessarily on the other.

The following Table will show the number of cases in which the frozen section was of use to us.

Clinically diagnosed as Carcinoma	5 cases	Diagnosed benign on Frozen Section
Clinically diagnosed as Benign lesion	4 cases	Diagnosed Carcinoma on Frozen section

It will be seen from this that valuable information was given to the surgeon in 9 cases. 5 cases were saved from undergoing a radical operative procedure. In the rest of the 16 cases, the clinical and frozen section diagnosis concurred. In none of the twenty-five cases was the frozen section diagnosis disproved by the subsequent paraffin section examination.

The following two cases are reported with a view to show how important it is to do a frozen section before a more radical operative procedure is undertaken.

#### CASE No. 3417

Clinical History: Woman aged 40 years, Hindu, obese and healthy looking was admitted to the hospital for a lump in the breast. Duration 2 months. The tumour

was situated in the centre of the breast and was 5 cms. in diameter. It was hard with irregular margins. The nipple was retracted. There were nodes felt in the left axilla.

The clinical history was very much in favour of the diagnosis of carcinoma.

It was decided to do a frozen section and so the tumour was excised locally, to be followed by radical amputation if found to be malignant.

On the gross examination of the specimen it presented an elastic and rubbery feel. Absence of discrete mass, lack of cicatrization and chalky points, suggested the diagnosis of an inflammatory process.

The microscopical examination of the frozen section showed the following features. There were ducts and alveoli of the mammary acini surrounded by connective tissue. There was a large amount of inflammatory exudate consisting of plasma cells. There were also seen degenerating alveoli and macrophage cells loaded with lipid material. Plasma Cell Mastitis was the diagnosis of this lesion. (Figs. 1 and 2). The three outstanding histological characteristics of this lesion are:—

- (i) Marked infiltration by plasma cells. This cell is a rare occurrence in other lesions of the breast.
- (ii) Proliferation of the cells lining the ducts: They are hyperchromatic and pile up some times six to ten rows deep. This gives an appearance at times difficult to distinguish from comedocarcinoma.
- (iii) The formation of giant cells together with their arrangement, sometimes make it difficult to distinguish it from tuberculous mastitis.

#### CASE No. 3663

Clinical History: 31 year old Parsee woman complained of a lump in the right breast. Duration 2 years. The lump was small to begin with but has gradually increased in size.

The clinical examination revealed that the right breast was slightly bigger than the left and immediately below the right nipple in the lower quadrant was a well-

defined hard moveable mass 5 cms. in diameter. There was a certain amount of thickening in the tail of the right breast.

The frozen section method of diagnosis was again resorted to and the lump was excised. On examination of the gross specimens there were seen two nodules. The smaller was ovoid, measuring 4 x 4 x 2½ cms. and had a similar appearance. The tumour did not show a definite capsule and seemed to gradually merge into the surrounding breast parenchyma. There was no evidence of chalky points or streaks.

The microscopic examination of the frozen section showed large and small lobules of mammary acini separated by dense bands of connective tissue. The lobules of the gland tissue show a diffuse orderly proliferation of small alveoli with a considerable increase in the acinar and intraductal cells. In the central portion, the acini are broken up into small groups of cells which are drawn out into thin streaks or clumps by fine strands of interlacing fibrous tissue, giving an appearance of pseudo-infiltration. (Fig. 3)

The diagnosis of this condition is fibrosing adenomatosis. The histological picture very closely resembles a carcinoma and if one has not seen a preparation before, one is likely to commit an error in the diagnosis. Subsequent paraffin sections have confirmed the above diagnosis.

These two cases thus bring out the value of frozen sections. Both these lesions are precancerous and often local resection is enough to cure the patient. It is not necessary to sacrifice the whole breast.

## CONCLUSION

A good frozen section technique entails facilities and experience at cutting and staining such sections. If these facilities are not available the surgeon should familiarise himself with diagnosing a lesion by naked eye examination alone. The gross examination of the specimen is often sufficiently instructive to enable an experienced surgeon to decide on a more radical operative procedure.

Consideration of the patient's complete history and consultation with the clinician are frequently necessary and it would seem that this might be done beforehand in the case of frozen section at operation. The criticism of the frozen section at operation may be in large part a criticism of lack of thoroughness in the preoperative clinical study of the patient by the Pathologist and the Surgeon.

A complete list of references has not been appended. The following have been most helpful in the preparation of this paper.

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## THE PROBLEM OF CARCINOMA OF THE BREAST IN WOMEN

by D. J. JUSSAWALLA, M.S.—Bombay.

Perhaps more has been written about cancer of the breast than of any other single regional form of cancer. Yet, there is possibly no more debatable subject in the wide realm of oncology, than that under discussion to-day. The voluminous literature that has steadily grown around this subject, bears ample testimony to this fact.

It has been our chief endeavour at the Tata Memorial Hospital to assess and sift facts from near and pseudo facts and base our approach to the problem of cancer on the lines of a policy chosen with deliberate care and attention, on the basis of the experience of other workers and on our own observations. In the next few minutes

at my disposal I shall aim to set before you what we have been trying to achieve in cancer of the female breast. I shall also try to explain why we have chosen to treat cancer of the breast in the way we are doing at present at the Tata Memorial Hospital.

In the past  $3\frac{1}{2}$  years we have had 200 cases of cancer of the breast in the female. Unfortunately I shall not be able to show you how far we have succeeded in combating this disease as we are yet not even 4 years of age. No cures worth mentioning can be claimed under 10 years or at least 5 years of freedom from this disease, as even untreated cases, on an average, live for  $3\frac{1}{2}$  years and a few, even 5 years or more before succumbing.

I shall now proceed to classify our patients with mammary cancer.

#### *The Age Distribution :*

The youngest woman was 26 whereas the oldest was 83. This once again makes us realise that cancer is no respecter of age. The commonest period of occurrence was between 35 and 55.

#### AGE GROUPS AMONGST 200 CASES

Age Group	No. of Cases	Per centage
25—35	22	11
36—45	69	34.5
46—55	62	31
56—65	36	18
65 and over	11	5.5

It is nowadays usually taken for granted that the cases in the younger age group have a relatively poorer prognosis. Unfortunately this idea has arisen from numerous statistical reports based on small series of cases. There has been very little observation on the prognostic value of different factors in the data from a large group of cases. A valuable review is given by MacDonald on 2636 cases from the archives of the American College of Surgeons. He has shown that age is not an all important prognostic factor. Indeed he found that there was a more favourable outcome for patients in the fourth than in the sixth decade.

#### *Duration of Symptoms :*

It is an unfortunate fact that patients with breast cancers come to the hospital for treatment quite late. This is more applicable to patients in our country than perhaps anywhere else in the world.

#### DURATION OF SYMPTOMS

Within 1 month	..	20 cases	10%
Within 3 months	..	40 cases	20%
Within 6 months	..	42 cases	21%
6 months or more	..	98 cases	49%

Thus nearly  $\frac{1}{2}$  of our cases come to us more than 6 months after the appearance of the first symptom. The shortest duration was 3 days in the case of a private patient and the longest was 10 years. When we shall be in a position to evaluate our 5 year cures this long duration of the disease will very probably bring down our survival figures. Though this is not the most important prognostic factor it comes high in that list.

The first symptom noted was a lump in the large majority of cases (82.5%). Thus :—

#### THE PRESENTING SYMPTOM

Lump	165 cases	82.5%
Ulceration	25 cases	12.5%
Pain	6 cases	3.0%
Discharge from the nipple	4 cases	2.0%

The infrequent occurrence of pain as a presenting symptom is well known in carcinoma of the breast and we find that only 3% of patients sought medical aid because of pain. This is unfortunate as otherwise patients would come to us early. The discharge of blood from the nipple was seen in only 2% of our cases. It is regrettable that too much stress is laid in surgical textbooks on a symptom which is rarely complained of.

#### *Location of the Cancer :*

Most authors have observed that the upper and outer quadrant is the commonest site of cancer in the breast. In our series this was so in  $\frac{1}{3}$ rd of the cases. The

upper half of the breast was involved in 51% of cases. The explanation for a pre-dilection of cancer for the upper half lies in the fact that lymphatic drainage of the breast in this region is poor because of inadequate support. The observations of most surgeons is unanimous on this point and should afford ample grounds for recommending a good type of uplifting brassiere specially for women with full and heavy breasts.

#### LOCATION OF CANCER IN THE BREAST

Upper outer quadrant ..	66 cases	33%
Upper medial quadrant ..	20 cases	10%
Both upper quadrants ..	16 cases	8%
Lower lateral quadrant ..	18 cases	9%
Lower medial quadrant ..	14 cases	7%
Both lower quadrants	Nil	Nil
Lateral half only ..	84 cases	42%
Medial half only ..	34 cases	17%
Upper half only ..	102 cases	51%
Lower half only ..	32 cases	16%
Central ..	34 cases	17%
Axillary tail ..	4 cases	2%
Entire breast ..	28 cases	14%

Distribution according to different communities in Bombay.				Popula- tion.
Deccanics ..	60 cases	30%	..	1,200,000
Gujaraties ..	24 cases	12%	..	510,000
Muslims ..	28 cases	14%		
Parsees ..	30 cases	15%	..	59,000
Northern Indians ..	4 cases	2%		
Europeans and Anglo-Indians ..	18 cases	9%		
Jews ..	4 cases	2%		
Indian Christians ..	32 cases	16%		

If these figures are corrected for the relative difference in the population of each community, the outstanding pre-ponderance amongst the Parsees, 15 times commoner than in the Gujarati Hindus, should bear closer investigation. Again, the rarity of the disease in the large Gujarati community may be noted with interest. We realise that these are relative figures and there may be many factors ill understood by us which may be responsible for this variation in

incidence. We may state that the records of our clinic do not show a pre-ponderance in the attendance of any particular community. This is however hardly the time to dilate on this point.

Of the 200 cases with mammary carcinoma, 35 had been treated elsewhere and were referred for treatment of recurrent or residual disease. Of the remaining 165 primary cases, only 90 were suitable for radical surgery; the other 75 cases were either given X-ray treatment or had a simple removal of the breast for palliative purposes or had combined treatment. Thus the relative operability rate was 54% calculated from the primary cases that came to us whereas the absolute operability rate was only 45% calculated from the total number of breast cancers that came to the hospital. This latter figure truly indicates the limitations of surgery in this disease and denotes the percentage of patients with breast cancer who have a fair chance of cure as a result of treatment. That more than half the number of patients do not even have a chance to get cured is indeed a deplorable state of affairs. That this figure can be improved upon has been the experience of most American clinics. The necessary conditions towards this future improvement would seem to lie in the education of the laity, and a wider propaganda to make the public cancer-conscious. It only remains then for our good friends, the general practitioners to send all cases with a lump in the breast for a thorough investigation to modern centres of treatment.

It has been our policy to perform a radical mastectomy on all operable cases. We are convinced that simple mastectomy is not good enough to attain the maximum number of cures. Those cases alone where a radical operation is contra-indicated and a foul smelling fungating mass makes the life of the patient unbearable, are treated by simple excision of the breast. We are aware however that to-day there is a school of surgical thought which believes in the adequacy of simple mastectomy in "curable" cancer of the breast as a treatment of choice even in the most favourable cases. Some years ago such a statement would not have been seriously considered but to-day some

leading surgeons maintain that mammary carcinoma is curable only when it is localised to the breast and that simple mastectomy would then suffice to effect a cure. They believe that if microscopic spread has taken place beyond the confines of the organ even a radical mastectomy would be of no avail and therefore should not be done.

A comparison of the best results achieved by either of these types of surgery would provide the answer to this problem. If we restrict our observations to the Steintal, I type of case the maximum 5 year cure rate reported after simple mastectomy has always been in the region of 38 to 50%, while with radical mastectomy it is between 81 to 93% (Lane Claypon, Pack & Livingstone). This means that the cancerous growth in these extra 50 to 60% of cases had extended beyond the confines of a simple mastectomy but was yet within the boundaries of radical surgery.

Furthermore there is convincing proof to-day, to show that it is quite unsafe to make a clinical diagnosis of involvement or otherwise of axillary nodes. Harrington after a study of 5026 case records of radical mastectomies found that in 29% of cases clinically thought to be free from axillary metastases there was pathological evidence of involvement. Lund of Boston places this figure at 40% and Lane-Claypon from a study of 2006 cases from the British Ministry of Health figures, at 50%. In our own series of 200 cases 18% were found to have been missed clinically. Thus if 18 to 50% of cases in Group I Steintal rightly belong to Group II the futility of even attempting a selection of "early" cases for simple mastectomy could be readily recognised.

Similar arguments may be brought forth to show that irradiation alone or together with simple mastectomy can never claim to cure as many breast cancers as radical mastectomy.

Keynes is nowadays able to show a 65% crude survival rate in Group I cases and a 26% rate in Group II cases with interstitial radiation. These figures however will be further diminished if a correction factor for many unbiopsied cases is applied. Even as it stands the survival rate compares unfavourably with that after a radical opera-

tion. Singularly enough nowadays, Keynes himself recommends surgical removal of the primary tumour, which should be more amenable to accurate needling and is usually more sensitive than the metastases. Haagenson from the Presbyterian Hospital in New York has shown that only 50% of all breast lesions are correctly diagnosed clinically by experienced men. At the Mayo Clinic a study of 100 breast cases was carried out where an early cancer was considered a possibility and in 73 of them the lesion was found to be of a benign nature. This would clearly show that the end results after radiation do not give a correct impression unless supported by pathological evidence, of cancer.

As a final word against irradiation as the sole method of treatment in the most favourable cases, we may quote Pack and Livingstone who state that from amongst all the published results after radical irradiation of breast cancer 50 to 75% of cases were found to have residual disease when the breast was subsequently examined after removal. In the case of axillary metastases which are definitely known to be more resistant to radiation the value of such treatment would certainly be very doubtful. Adair and Stewart found viable cancer cells in 80 to 90% of the axillary nodes which had been subjected to radiation.

These figures also serve to show that the value of pre-operative radiation is not at all high and it yet remains to be demonstrated that any great improvement in 5 year end results is produced by this method, to recommend it as a routine procedure. On the contrary it was found at the New York Memorial Hospital, from an unpublished report, that healing was very much delayed after a subsequent radical mastectomy and some cases had massive sloughing of the skin flaps and a few, of the anterior chest wall itself when only moderate doses of X-ray were delivered to the breast pre-operatively. We therefore adopt this procedure only in exceptional cases at the Tata Memorial Hospital.

Portmann and later, White from the Roosevelt Hospital have shown however that post-operative X-ray treatment has some value but only when pathological evi-

dence of cancer is found in the axillary nodes after radical mastectomy. White has shown a 10% increase in the 5 year cure rate in such cases. There is no demonstrable increase, after post-operative X-rays, in the salvage rate of patients, where cancer is limited to the breast and the axillary nodes are free from disease. At the Tata Memorial Hospital we strictly adhere to this routine and post-operative X-ray treatment is given only when pathological evidence of viable cancer in the axilla is available.

The real value of irradiation however, becomes evident in inoperable cases where quite spectacular results are sometimes seen; but more in the individual rather than in a group of cases. We believe that it is best for a patient with inoperable disease to have the least possible surgical interference. Deep X-ray treatment takes over complete charge of such cases. I shall not deal here with the technical side of deep therapy, perhaps our friends the radiologists who are with us here to-day, may dwell on that aspect of the problem.

Finally there comes the case with an operable breast cancer but with other contra-indications to major surgery. A simple mastectomy with post-operative radiation is our treatment of choice in such cases. Then again the fungating foul smelling cauliflower cancer of the breast begs for the surgeon's knife for local removal, to make the life of the patient more comfortable.

I would like to mention a few points in the technique of radical mastectomy which we always follow, and which might be of interest to you. We make it an absolute condition precedent to the treatment of a case to obtain pathological proof of cancer either by aspiration biopsy or by frozen section at the time of operation. A formal biopsy should never be attempted if a radical mastectomy cannot be undertaken for any reason within 48 hours, as the chances of dissemination then are otherwise great. Ewing and Stewart have shown this very clearly. We do not remove an abundance of skin around the tumour mass. A greater extent of superficial fascia is removed than the skin and in most of our cases the wound could be closed, with a few relief incisions at the most. Our local recurrence rate of

12% compares very favourably with any similar report in the literature. (Haagensen reports 20%, Kunath 19%). Another principle we strictly adhere to is to avoid handling the tumour during the operation. As far as possible we remove the tumour first if it is fairly small and then go ahead with the radical operation. If it is big, a small wedge is removed from the superficial solid part of the tumour and the incision closed up. A complete removal in such cases opens up the tissues planes leading to a dissemination of tumour emboli.

In a most interesting and instructive series of experiments conducted by Batson of Philadelphia it was shown that there is a distinct and separate system of veins called the vertebral system with rich valveless ramifications, and connections with the cranium, body wall and visera, which is the main channel for spread of aberrant metastases to distant parts of the body. The absence of lung involvement has been a constant stumbling block to current theories. Even a patent foramen ovale has been used to explain these metastatic paradoxes. That there is a possibility of transportation of tumour masses by veins, has been definitely established by Willis and others. Injection of breast venules by Batson seemed to duplicate the pattern of aberrant breast cancer into the vertebrae, ribs, shoulder girdle and skull.

This vertebral vein complex was found to act either as a venous pool or a by-pass for other venous systems. Injection experiments in living monkeys fully corroborated this observation.

These veins were found to have hardly any valves capable of preventing a reversal of blood flow which occurs with every act of coughing or straining or lifting the upper extremity. The blood is not only prevented from entering the thoraco-abdominal cavity but is actually squeezed out of the cavity into the vertebral veins and with it the tumour emboli pass easily to their final destination without having to get through the lung filter at all.

With this in mind we have taken care to see that no undue pumping of tumour emboli occurs on the operating table through squeezing of the tumour, specially when it



could not be removed locally before a radical mastectomy.

Haagenson and Stout from the Presbyterian Hospital, New York, have shown that there is a definite relationship between the length of operation and the 5 year cure rate, the one rising in direct proportion to the other. We therefore make no special effort to shorten the time of operation by hurrying over the details of dissection, particularly in the axilla.

Finally I would like to mention our criteria of operability. Age is no bar to a radical operation if the general condition is not contra-indicative, neither is the location of disease in the breast.

#### CONTRA-INDICATIONS TO A RADICAL MASTECTOMY

1. Carcinoma arising during lactation or pregnancy.
2. Advanced ulceration or extensive oedema of skin over the breast.
3. Involvement of the supra-clavicular or intercostal nodes.
4. Distant metastasis.
5. Inflammatory type of cancer.
6. Fixation to chest wall.
7. Low general condition.

Working along these lines we have had so far the following results.

#### 90 RADICAL OPERATIONS

	Survival figures			
	Alive to-day		Untraced	Dead
	Free from disease	Recur- rence		
90 Radical operations	56	6	12	16
With axillary metastasis 55 cases	30	4	9	12
Disease limited to the breast 35 cases	26	2	3	4

I shall not comment on these figures because not a single case has yet passed the 5 year mark and many have been followed for only 1 year after operation. Other

workers have found that the cure rate drops by 40 to 50% in the 5th year when the axilla was involved. The commonest post-operative complication was infection of the skin flaps. In one case the whole flap sloughed away and recourse was had to secondary skin-grafting. There was one post-operative death from cardiac failure.

#### NATURE OF COMPLICATIONS

Infection Slight	Infection Massive	Lung complication	Lymph- oedema	Throm- bophle- bitis	Death
15 cases (or 16%)	3 cases	6 cases	15 cases (or 16%)	2 cases	1 case

Finally I would like to dwell a while on the rationale of artificial menopause in carcinoma of the breast. Dresser and later Taylor from Boston, Massachusetts have shown that about 35% of cases derive some benefit from this procedure. On closer inspection of these cases Taylor found that the prophylactic value of artificial menopause was practically nil and it was only in the younger women with metastases to the bones that arresting the function of the ovaries was beneficial. Castration experiments at birth in cancerous strains of mice at present being carried out in our laboratories suggest that the presence of the ovarian hormone is an essential factor in the malignant proliferation of the cells of the mammary gland. Unfortunately however the temporary character of the regression and the eventual rapid progress suggests, that the cancer can adjust itself to a lack of this growth stimulator in human beings. We may benefit by the temporary check to the cancerous growth by directing vigorous deep therapy to the existing foci of the disease. The 5 year cure reported by Clarkson and Barker in a case of breast cancer with metastases to the skeleton adds further evidence in the same direction.

Since the beginning of this year the use of Stilboestrol and allied preparations in advanced cancer of the breast has come in for a good deal of notice in the medical press. It will therefore not be out of place to refer to the relative value of oestrogen therapy in advanced cases. Conflicting results have been reported so far. A few

spectacular results have been achieved in women above the age of 58. No one has yet claimed a cure, but several writers report marked improvement, such as a feeling of well-being, resumption of active life and the healing of ulcers. We have only just started using stilboestrol for our advanced cases, and we are glad to confirm that in half a dozen cases of advanced cancers of the breast in old women, there has been a good regression of the primary tumour. The controlling factor here, seems to be a biological one, namely the age of the patient in relation to the menopause. I have already referred to the presence of the ovarian hormone as an essential factor for the growth of the breast cancer cell and that the destruction of the ovary puts a temporary check on further growth of the cancer. At the same time we find that on presentation of a synthetic oestrogen there is again check and regression of the cancer when tumour cells have not adapted themselves to the presence of this synthetic oestrogen. You will agree that this is quite an interesting phenomenon which needs further investigations by pathologists and clinicians alike.

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### MALIGNANT MELANOMA OF THE RECTUM

*A Case Report by Col. V. R. MIRAJKAR, O.B.E., F.R.C.S., I.M.S. (Retd.) and*

*Y. V. SACHDEVA, M.S.P.C., M.S.—Lahore.*

A malignant melanoma may occur at almost any point on the surface of the body, but the common sites are the forehead, the neck, the abdominal wall and a nail-fold. A nail-fold or bed is the commonest of all. In some sites the primary tumour remains small although metastases may be numerous; in others the tumour may grow rapidly to a large size and may ulcerate.

In general, a malignant melanoma may be regarded as the most aggressive of all tumours. It has pronounced infiltrating characters and therefore spreads widely by direct extension. In addition it tends to invade the lymph nodes. The tumour cells may actually grow in the lymph vessels and give rise to multiple secondary growths in their course. The secondary deposits in

the lymph glands are frequently more deeply pigmented than the primary growth.

In many cases a malignant melanoma metastasizes by the blood stream and gives rise to multiple secondary growths in the bones, lungs, brain, liver, kidney, skin and almost any other part of the body. Metastases may be so numerous and wide spread that the condition is known as generalised melanosis. In a few cases the secondary growths are non-pigmented or only pigmented in patches.

Malignant melanoma occurring in the gastro-intestinal tract is an uncommon condition although diffuse melanosis of the colon is a common condition in elderly subjects, and is generally referred to the elaboration of blood pigment extravasated in the mucosa as in cases of anaemia or other blood conditions. Its extent recalls the diffuse pigmentation by chromatophores in the intestinal tract of lower vertebrates. Dawson studied a number of benign and malignant melanomas, none of which occurred in the anus. Chaliar and Bonnet have analysed sixty-four cases of melanomas of the intestinal tract and found that 2 or 3 percent of all melanomas occur in this region and that most of these are derived from the anal epidermis and infiltrate beneath the mucosa.

The exact origin and significance of melanin in malignant melanomas is a matter of controversy. The uncertainty of its origin is shown by the presence of melanin in both carcinomatous and sarcomatous growths. Although melanin occurs normally in the choroid of the eye, in the skin and in the hair, and is found in fairly large amounts in certain new growths, it is extremely difficult to isolate, since it does not crystallise and it is insoluble in water and other solvents. Melanin is soluble in strong alkalies or acids, which, however, change its composition. This makes it extremely difficult to learn its exact chemical composition.

It is believed that melanins are a group of nitrogenous compounds closely related to the proteins. Some believe that melanin found in tumours is purely of endogenous source, originating either from a special pigment cell, or from cells which have

taken on the function of pigment formation. Dawson says, "The term melanoma emphasizes the specific character of the tumour cells, which contains a variable amount of an iron-free pigment melanin. Colour or pigment in the animal kingdom, especially in the highly pigmented vertebrates, the frogs and reptiles, has long been held to belong essentially to a specific cell, the 'chromatophore,' and the claim of the exclusive relation of this cell to pigment production is only emphasized in the admission (a) that the overflow from the chromatophores may be transported to epithelial cells of the epidermis, and (b) the deposit of this excessive pigment from the mesoblastic chromatophore, in certain cells of the foetal epidermis may excite these cells to proliferate and cause them to assume the function of pigment production." The pigment cell on the other hand, is held by others to have arisen from the ordinary connective tissue cell of the corium, or to be endothelial in origin, or again exclusively of epidermal origin with further contention that the connective tissue cells merely carry off the surplus in the lymph paths.

We may or may not admit the specific characters of cells which form the melanin pigment, but we all recognise the great variations in the histological make up of the tumours containing pigment. Even though we admit the source we still do not know the significance of the presence of the pigment in malignant tumours.

We present a case of malignant melanoma of the rectum:

### CASE REPORT

Barkat, a male aged thirty-five was admitted on April 10, 1944, to the Surgical side of the Mayo Hospital, Lahore. The history of the case revealed that the patient had been in good health till nine months ago, when he noticed some irregularity of bowel action but he did not seek any medical advice for it. Two months later he started passing some blood along with stools and later on the blood was found trickling in the intervals between defaecation. There was tenesmus and increased frequency of defaecation for the last eight months. The patient had been noticing

some enlargement of the inguinal lymph nodes for the last 3 or 4 months. About a month ago the patient consulted a 'Jerrah' (quack) who diagnosed him as suffering from external piles and removed them. Since this operation the troubles of the patient had increased as he started passing more blood, mucus and even pus.

Patient on examination was found to be emaciated and anaemic. The inguinal lymph nodes were enlarged, soft, doughy and matted together. Rectal digital examination revealed two polypoidal masses in the anterior wall of the anal canal and in some places ulcerated. On pushing the finger upwards, the mucous membrane was found to be intact but there was a mass felt in the pouch of Douglas towards the left side, soft, but not ulcerated. Proctoscopic examination confirmed the above findings and there was no ulceration of the mucous membrane in front of the pelvic mass.

*Operation Notes.*—26th May, 1944:—

Anaesthesia—Spinal stavain Barker's solution; 1.2 c.c. (Hyperbaric).

Left paramedian sub-umbilical incision through the rectus muscle. On opening the abdomen a swelling was found in the pouch of Douglas. As the coils of intestines were pushed aside to the upper part of the abdomen, small patches of black colour were noticed, some loose, some adherent and some patches were found on the appendices epiploicae. At first it was thought to be due to sub-peritoneal clotted blood but the colour was much darker than the ordinary blood clots.

On exploring the pelvis the rectum was found to lie on the extreme right from the sigmoid downwards on account of a big sized retroperitoneal mass which extended deep down to the level of the Douglas pouch. The peritoneum was intact although stretched. The whole mass had almost coal tar appearance. This mass was identified as rectal and perirectal lymph glands. From the naked eye appearance a diagnosis of malignant melanoma was made and as the lesion found in the pelvis was immovable, we did not enlarge the incision upwards to explore the rest of the abdomen. Small bits of the mass in the pelvis were removed

for pathological examination. There was free oozing which was controlled by hot packs. Another piece was removed from the appendices epiploicae for section and pathologist's report.

The loop of the sigmoid colon could not be easily delivered into the wound as the mesentery was contracted and shortened. In spite of this, the available loop was brought out and transfixed by a glass rod and the rest of the peritoneum was stitched up without drainage. The loop was not opened at the time of operation.

The loop was opened by hot cautery on the 3rd day after operation. Some gas and faecal matter was passed.

The patient's condition became worse and he expired on the 30th May, 1944.

It was with great difficulty and persuasion that the relatives agreed to only a partial post-mortem (only the abdominal cavity was allowed to be opened).

*Post-mortem Report:* 30-5-1944: External appearances, etc.:

There were two black polypoidal masses in the anterior wall of the anal canal which were ulcerated. On pushing the finger up in the rectum, a mass semisolid in consistency was felt in the left side of the pelvis. The inguinal lymph nodes on both sides were enlarged to the size of an orange. On cutting the skin over the right inguinal swelling, it was found to be black in colour and adherent to the femoral sheath. This mass of glands along with adherent femoral sheath was removed for microscopic examination.

*Abdomen*—By enlarging the operation wound the abdomen was opened up and black seed like masses were noticed scattered about in the omentum. A piece of omentum was removed for preservation (Fig. 3). The pelvic glands were found enlarged and black. The lower part of the sigmoid colon and rectum were removed for preservation. The growth was black and tarry and infiltrating the rectum (Fig. 1).

*Spleen*—not enlarged, nor any secondary deposits seen on naked eye examination.



Fig. 1. Photograph of the rectum etc., removed at the autopsy.



Fig. 2. Liver showing secondaries of different sizes.

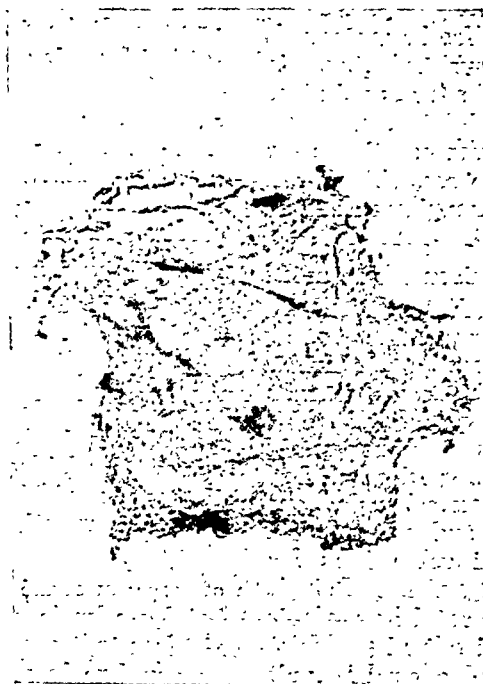


Fig. 3. Piece of greater omentum studded with black nodules (secondary deposits).

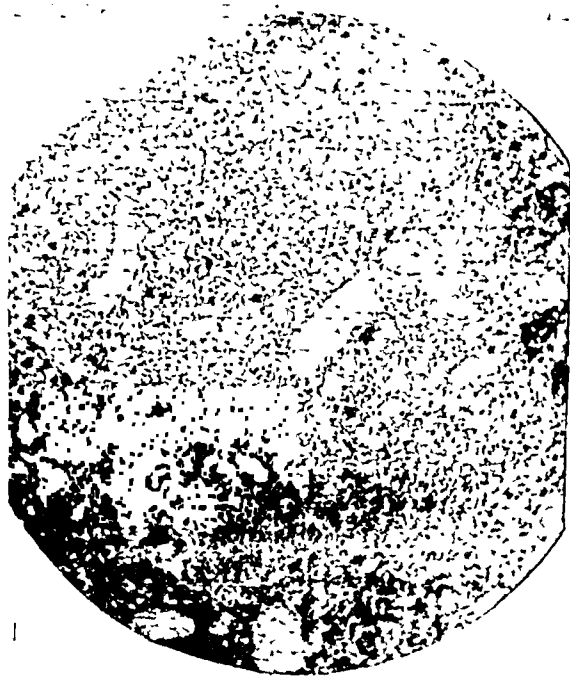


Fig. 4. Microphotograph of a section of the growth in the Rectum. This field shows the alveolar arrangement of the melanotic cells.  
Low power view.

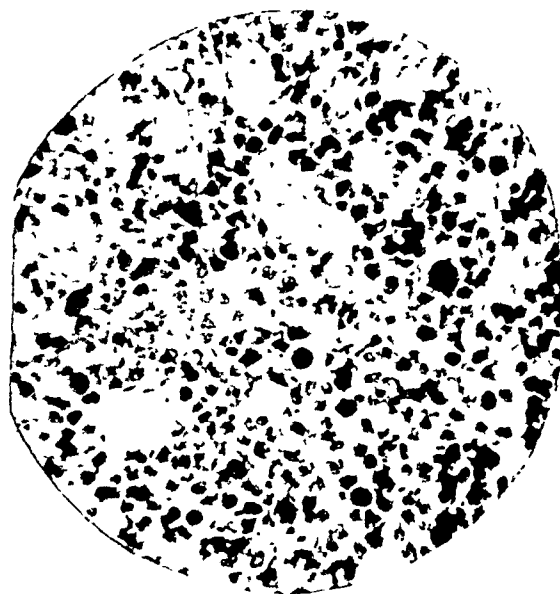


Fig. 5. Microphotograph of a section of the growth in the Rectum.  
High power view.



Fig. 6. Microphotograph of a section of the secondaries in the liver.  
Low power view.

Liver—showed several secondary deposits varying in size from that of a black dot to that of  $1\frac{1}{2}$ " in diameter. The bigger secondary deposits showed umbilicated centres which were also black. Kidneys and supra-renals did not reveal any deposits of melanoma on naked eye examination.

#### *Microscopic study of different sections :*

Biopsy results—Section from all the pieces removed at the operation showed malignant melanoma.

Growth in the Rectum—showed malignant melanoma in the wall of the rectum, the melanoma was extending from outer layers inwards, the mucous membrane had scanty pigment which was most marked in the outermost layers. (Figs. 4 and 5)

Umbilicated nodules from Liver showed deposits of malignant melanoma destroying the parenchyma (Fig. 6). The black dot like nodules showed the same deposits of the tumour. One area in this piece showed deposit without any pigment.

Inguinal lymph nodes. Section from them showed the destruction of the node by the growth. The black dot like nodule in the fat of omentum had the same appearance of malignant melanoma. Sections from spleen,

kidneys, adrenals had no evidence of secondary deposits.

It is a pity that a complete post-mortem of this case was not allowed.

We are very grateful to Dr. A. N. Goyle and Dr. Manmohan Singh of the department of Pathology, K. E. Medical College, for the post-mortem examination and the study of the different sections. Our thanks are also due to Dr. K. N. Kashyap for the microphotographs and to our House Surgeon Dr. L. R. Pathak who has helped us in presenting this case.

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## STRICTURE OF THE COMMON BILE DUCT

by O. V. JOOMA, M.B., B.S. (Bom.)—Bombay.

The object of reporting this case is to impress the fact that this is probably the first case of its kind treated in the K. E. M. Hospital though quite a number have been reported in literature. Patient Mr. P. R., male, aged 33 years, seaman by occupation, was first admitted under Dr. N. D. Patel, M.D., M.R.C.P. (Lond.), and subsequently transferred under Dr. A. V. Baliga, F.R.C.S. (Eng.), with the following complaints:—

- (1) Intermittent attacks of Jaundice  
—8 months.
- (2) Severe itching all over the body  
—8 months.

- (3) Pain in the right hypochondrium  
—8 months.

O.D.P.:—About 8 months before his admission patient had an attack of nausea and malaise which lasted for 2 days followed by the development of jaundice and pain in the right hypochondrium which was relieved by application of leeches. The pain and jaundice continued for 4 months after which the jaundice disappeared and the patient was free from pain. About 3 months later patient developed jaundice again without any pain, but it was noticed that the depth of jaundice was increasing from day to day. For the last 20 days prior to

his admission patient has been passing clay coloured stools.

*Past Illness.*—Nothing of importance.

*Personal history.*—Sailor in a merchant ship for 2 years.

*Addictions.*—Little alcohol occasionally.

*Family history.*—Nothing of importance.

*General Examination.*—Patient fairly well-built and nourished; conjunctiva and nails yellow.

*Local Examination.*—

*Inspection.*—Abdomen moves well on respiration; no areas of fullness. Hernial orifices normal.

*Palpation.*—Liver enlarged for about 3 fingers below the costal margin and tender; spleen not palpable.

*Percussion.*—Tympanitic note all over, except dullness in the right hypochondrium.

R. S.	} N. A. D.
C. V. S.	
N. S.	

*Investigation.*—Urine Bile salts + +

(Pre-operative) Bile pigments + +.

Bleeding time .. 6 minutes.

Coagulation time .. 10 minutes.

Prothrombin time .. 5½ minutes.

Van den Bergh

Reaction	Direct immediate positive.
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Icterus Index 120.

(Before operation)

*Operation.*—Patient was operated on on 17-11-1943 under general anaesthesia by Dr. A. E. De Sa, F.R.C.S. (Eng.). Abdomen was opened by the right paramedian incision; the gall bladder palpated but it was not distended. Some small stones, however, could be felt. The common bile duct was next palpated and something like stones was felt along its course but on cutting it open no stones were seen. The gall bladder was then opened up and it contained sticky mucus with 3 flake like stones which were removed. The gall bladder was then drained and the abdomen closed.

Pathological examination of the material from the gall bladder indicated pigment

stones. The patient got over the operation quite well. His jaundice and other symptoms were alleviated but there was no change in the Van den Bergh reaction and Icterus Index. These laboratory findings indicated that the cause of obstruction to the flow of bile was not removed and accordingly patient was operated on again by Drs. Baliga and De Sa on 13-12-'43. After opening the abdomen a rubber catheter was passed through the cholecystostomy opening but the catheter did not go through the cystic duct. It was then decided to do a retrograde dilatation of the common bile duct through the duodenum. Accordingly the 2nd part of duodenum was opened up; the ampulla of Vater located and a probe passed upwards through the ampullary opening. The probe went up for some distance but could not be passed any further as it met with some resistance. It was then felt that probably a stricture must be present proximal to the ampullary opening. The stricture was then dilated with Lister's bougies upto 7/10 Eng. and then a probe passed up the common duct but no stone was felt. A small rubber tube was passed through the ampullary opening with one end in the lower part of common bile duct and the other end in the 2nd part of duodenum. The duodenum was then sutured, the abdomen closed with a drain in Morrison's Pouch.

About 23 days after the operation the Icterus Index fell from 120 to 15 indicating the cause of obstruction was relieved and at the same time there was clinical improvement in the jaundice.

About 28 days after the 2nd operation the patient displayed symptoms of intestinal obstruction. Subsequently within the next fortnight he developed definite intestinal obstruction and at the same time the Icterus Index went up to 50. Hence on 26-1-1944 patient was operated on again by Dr. A. E. De Sa under spinal anaesthesia. The abdomen was opened by left paramedian incision. On opening the peritoneal cavity it was found that a coil of small intestine was adherent to the Right Paramedian Scar and there were few other adhesions between the loops of small intestine. The region of common duct and 2nd part of duodenum was palpated for the presence of the rubber



tube as it had not been passed in the stools so far, but it could not be felt. In trying to separate the adhesions, the bowel wall was torn and its contents oozed out. The torn ends of the small intestine were anastomosed. The abdomen was then closed with tremendous difficulty as there was a great deal of tension and the stitches through the peritoneum would cut out. About 4 days after the operation the patient developed a faecal fistula which refused to heal in spite of all treatment and the patient eventually expired on 12-3-1944.

### DISCUSSION

The above is obviously a case of stricture of the Common Bile Duct, probably of the benign variety. Benign strictures are occlusive or obliterative cicatricial processes and can be classified into the following types:—

- (1) Congenital Obliteration — Developmental anomaly.
- (2) Primary Inflammation.
- (3) Secondary Inflammation, associated with gall stones in the common duct.
- (4) Traumatic or Post-operative.

The case under consideration is obviously of the secondary inflammatory variety since we have had definite evidence of pigment stones in the gall bladder and it is quite possible that in their passage down the common duct these pigment calculi many have eroded the duct wall and thereby giving rise to an inflammatory process followed by cicatrization. In 1925 Judd and Burden reported two cases of this type

and since then a number of cases have been reported from the Mayo Clinic. Strictures of this variety are mostly confined to the pancreatic portion of the common bile duct since this is the narrowest and least distensible portion of the biliary duct system. These strictures are of a diaphragm type and do not involve the muscular coat and hence easily broken through by instrumentation.

The clinical feature of importance in such cases is an insidious appearance of jaundice which persists but with absence of pain or colic.

*Treatment.*—Is very suggestive in the sense that since the stricture can be easily broken through by instrument the rational line of treatment would be dilatation of stricture with insertion of buried tube, as had been done in the case in question.

### SUMMARY

- (1) A case of Common Duct Stricture is discussed.
- (2) Stricture associated with stones in the gall bladder or common duct.
- (3) Operative Treatment:—Dilatation followed by insertion of a buried tube.

My thanks are due to the Dean, K. E. M. Hospital and Drs. A. V. Baliga, F.R.C.S. (Eng.), and A. E. De Sa, F.R.C.S. for allowing me to report this case.

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## DISCUSSION ON CARCINOMA OF THE BREAST

(VI Annual Meeting of the Association of Surgeons  
held at Lahore in Dec. 1944.)

N. C. Joshie (Delhi): opened the discussion. His paper is issued as a supplement to this number of the Indian Journal of Surgery.

D. J. Jussawala (Bombay): the seconder, read his paper. This is published in full on pages 44 to 50.

K. P. Mody (Bombay): discussed the Radiological aspects of the question. He could not agree

with the Opener that Deep X-ray therapy was a luxury. The best results, he said, were obtained by a combination of Surgery and post-operative radiation. He quoted some figures from the Mayo Clinic. The difficulties connected with radiation were due to factors such as:—(i) the comparatively radio-resistant character of breast carcinoma, (ii) the large extent of area involved, (iii) the irregularity of the growth, (iv) the impossi-

bility of sterilising the lymphatics and (v) the danger of radiation fibrosis of the lungs. He described the technique. He used a 200 K.V. unit, 70 c.m. distance and 0.5 m.m. Cu filter. He used three fields for the breast with a dose of 2400 r to each field and 3,500 to 4,000 r to the axilla, the whole being administered in one course. Increase in the K.V. did not, in his opinion, materially affect the results. Primary radiation in all cases, he said, gave results inferior to those of operation. Pre-operative radiation has been given up. He said that simple mastectomy has no argument at all in its favour. Keyne's method of insertion of Radium Needles, he said, is as elaborate as a Surgical operation.

K. S. Nigam (Lucknow): related his experiences with 118 cases of breast Carcinoma, 64 of whom were operated on with no immediate mortality. He reported a 7 year survival in a woman of 25 years with lactation Carcinoma and spontaneous retrogression in two cases of diffuse Carcinomatosis. Operation was the treatment of choice in his opinion; he was against pre-operative radiation, but advocated post-operative radiation in all cases. He described his technique of operation and stressed on the need for avoiding mutilation and crushing of tissues. Concluding, he spoke on the need for propaganda in the press and for the establishment of a Surgical Research Laboratory.

G. D. Kapur (Lahore): referred to the unreliability of Clinical diagnosis in that too often contradictory reports are received from the Clinician and the Pathologist regarding axillary involvement. He deplored the non-availability of 'rapid section' methods and histological grading at all Centres. The introduction of conservative operation and radio-therapy has only tended to confuse the minds of Surgeons and, in his opinion, this 'therapeutic uncertainty' is definitely setting the Clock back in the treatment of this disease since the time it was put forward by the genius of Halstead, who laid down certain fundamentals. Radio-therapy he considered only palliative and not curative and is indicated only in wide-spread Cancer beyond the reach of excisional surgery. Pre-operative and post-operative radiotherapy have not justified their claim in reducing mortality. Radio-sensitivity was not to be confused with radio-curability and mere regression of a tumour did not mean that the Cancer was cured. The only chance lay in early operation and he said "Stop the discussion and educate the public to seek advice as soon as a lump is discovered."

M. G. Kini (Madras): stated that out of 148 cases of tumours of the breast seen by him, there were 3 cases of sarcomas of the breast which were reported in the Indian Journal of Surgery, Vol. VI, No. 4, 1944. He stressed the point that in his experience a few cases lived over a period of 7 years after operative removal. These cases were the ones which gave difficulty in diagnosis that it was cancer. The majority of the cases that came to the hospital presented no difficulty in diagnosis as it was possible not only to see the cancer but

also to smell it from a distance. Operation was undertaken in 30 per cent of such cases with temporary alleviation of the distressing symptoms; but some of them came back later with secondaries in the bones, particularly in the ribs, the spine and the pubic bones. He therefore stated that in his experience operative treatment for cancer was necessarily bad though the mortality immediately after operation was only 2 per cent.

He described a peculiar case of cancer of the breast in a woman aged 40 years who was admitted in May 1937 for a tumour of the breast which was not fixed and was freely moveable with no palpable glands in the axilla. The skin around

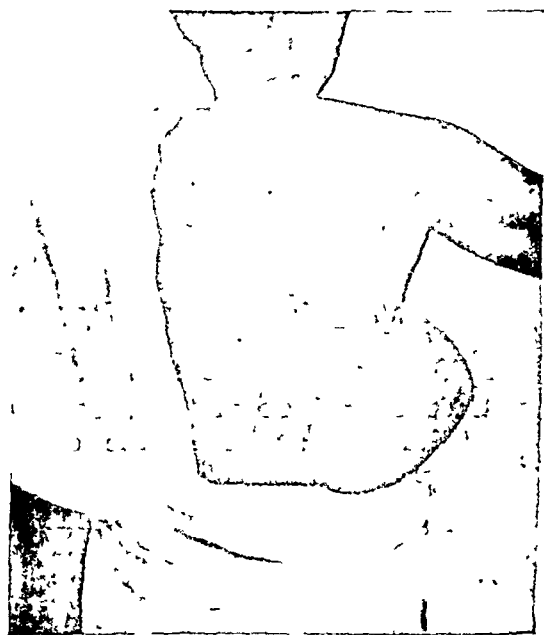


Fig. 1.

Illustrates the tumour in the left breast. (Kini)

the nipple showed lymphatic obstruction. The tumour was removed and on histo-pathological section it was reported to consist of spindle shaped cells resembling basal epithelium arranged in dense sheets. In places there was extensive necrosis giving the appearance of a structure of perithelioma. The glands showed chronic inflammatory lymphoid hyperplasia with no malignant infiltration. She was admitted again on 4-8-1938 with marked anaemia and an ulcerating growth in the region of Scarpa's triangle, left thigh. This was opened by a practitioner as an abscess; she had bled freely and, at the time of admission, the swelling had a crater and was found to contain a chocolate coloured blood clot with bubbles of gas. There was no recurrence at the site of the operation neither were there any secondaries appreciable in the bones or in the lymphatic area draining the breast. This growth was excised with a diathermy knife after building up the patient's condition and the growth was removed with the fascia

and portion of the muscle. She was in hospital for quite a long time. The growth was found to con-



Fig. 2. Photograph of the specimen removed at operation. Note the cystic degeneration of the tumour. (Kini)

sist of round and fusiform cells with hyperchromatic nuclei with scant cytoplasm resembling mixed cell sarcoma.

During her convalescence, she found a small lump on the right breast and she became anxious about this condition and on examination, the breast felt nodular with a lump of an appreciable size which could be felt with the flat of the palm. She stated that the tumour in the left breast which was removed previously started in the same way as a small lump and insisted that it should be removed. The breast was removed and on histopathological examination it was found to be a case of interstitial mastitis.

This case was demonstrated on account of its clinical peculiarity and histological appearances and the subsequent development of a connective tissue tumour in the left thigh which probably had no relationship with the cancer of the breast. It is unfortunate that every attempt to follow up this case proved a failure.

K. R. Chaudri (Lahore): gave a brief account of his experiences with cases of Carcinoma of the breast,

Col. Rameshwar: said he had come across a few cases of Carcinoma of the male breast in the Army proved on routine microscopic examination.

Maj. Banerji: of the District Laboratory, Lahore, spoke about the histology of Carcinoma of the male breast. They were usually a type of

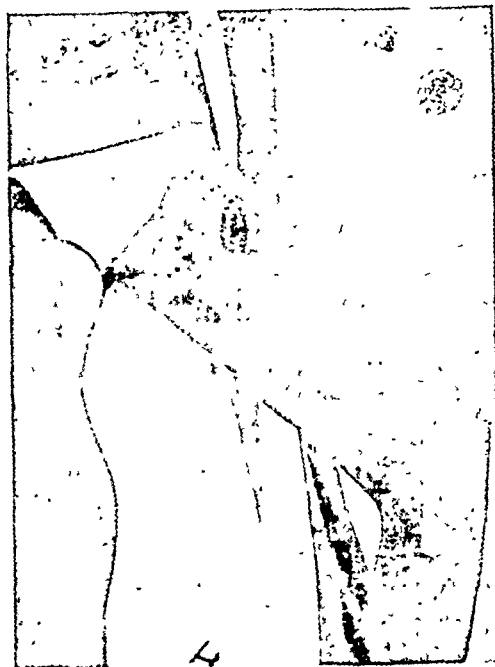


Fig. 4. Photograph of the tumour in the left thigh for which she was readmitted. (Kini)

Duct Papilloma with invasion of the basement membrane. Some squamous celled growths were also seen.

Riaz-i-Qadir (Amritsar): gave statistics from the V. J. Hospital, Amritsar. Only 38% of 42 cases were operable when first seen. 15% of the rest had a palliative mastectomy done. All operated cases are advised to have post-operative radiation. Follow up results were not available but 3 cases returned with recurrences within a year.

B. L. Kapur (Lahore): wished to be informed as to the attitude to be adopted towards pregnancy complicating Carcinoma.

P. Chatterji (Calcutta): referred to some of the difficulties in diagnosis—not all growths were painless to start with. Some of them came for pain. Occasionally Filariasis may be mistaken for Carcinoma. He had seen Carcinoma occurring in patients of 17 and 21 years. He considered that X-rays had a definite place in the treatment and he had also treated selected cases with local removal and implantation of Radium.

N. C. Joshic, the Opener, replied briefly to some of the points raised during the course of the discussion.

The President, R. N. Cooper, in concluding the discussion said that Physiology was not given its proper place in its relation to Surgery. The influence of the hormones in relation to Cancer needed study. He emphasised on the need for taking into account the end results in any classification adopted in this disease. He said that the absence of pliability of the breast was a valuable sign in

diagnosis. Trans-illumination may be useful and repeated examinations may be necessary. He referred to some points in the operation and stressed on the value of blood transfusion. He gave instances of the great variation in the degree of malignancy of these tumours. He referred to various new remedies and commented on their uselessness. The occurrence of spontaneous intermittent regression is a fact that has to be taken into account in the assessment of the results of any new remedy.

## EXTRACTS

### Anaesthesia in Abdominal Operations

(A discussion at the Royal Society of Medicine.)

G. Gordon-Taylor. For upper abdominal operations the ideal anaesthetic is a combination of novocain regional anaesthesia, and splanchnic novocain administered intra-abdominally in the prevertebral retroperitoneum, and very light chloroform (patient semiconscious, able to answer questions). Gas and oxygen is not advised for any prolonged operations. Spinal anaesthetics not advocated for gastric operations. If regional novocain be used, very good relaxation can be obtained, and retractors need hardly ever be employed. Spinal anaesthetics are useful in lower abdominal operations.

A table showing the operative mortality of gastrectomy under various anaesthetics is of interest, and may be summarised thus:

	Cases	Deaths	Percentage
Inhalation	414	17	3.9
High Spinal	600	48	8.0
Regional & Splanchnic	4,300	162	3.76

It is thus seen that full spinal anaesthetic is definitely contra-indicated for gastrectomy. For gunshot wounds of abdomen, regional anaesthesia is advocated, with light inhalation anaesthetic. For acute abdominal conditions, the same combination is usually best. Spinal anaesthetic is useful in emptying the bowel of gas, but must not be used in patients, who are collapsed or shocked, or in poor general condition. It is a good anaesthetic for early and fit cases of obstruction. For appendicitis, inhalation (chloroform) is probably as good as anything, especially if glucose is given preliminarily to stave off the toxic effects of chloroform on the liver.

Norman Lake advocated spinal percaïne of 1 in 1,500 or 1 in 1,000 strength, with an intravenous

saline containing 1 in 250,000 adrenaline, dripping at the rate of 50 to 60 drops per minute, and continuing during the operation, and after it until the blood pressure rises to normal. Intravenous Pentothal is used for induction, and gas and oxygen for continuation of unconsciousness. For acute obstruction, regional novocaine with a minimal quantity of intravenous pentothal is used.

A. H. L. Baker advocated regional 1 in 1,000 anethaine (amethocaine hydrochloride) introduced as posterior intercostal and splanchnic blocks (1 in 2,000 for the splanchnic block). This acts for 3 hours, a much longer time than novocaine. No general anaesthetic is given.

H. Dodd advocates regional novocaine or amethocaine, introduced into the abdominal wall along the costal margin (as far as the crest of the ilium of the side to be operated), and in a dose of under 200 c.c. altogether. Open ether is given as an adjuvant while exploration is being done, and if any pulling on viscera is required. In the opinion of the reviewer, for anaesthesia in India ether is too volatile, and we may sum up this subject by advocating the combination of pre-anaesthetic injection of  $\frac{1}{4}$  gr. morphine with 1/75 or 1/100 gr. atropine, with the following:—

(1) Regional novocaine (or amethocaine if an operation of more than one hour is anticipated) given all along the upper abdomen just below the costal margin, down to the level of the umbilicus in both anterior axillary lines. For upper abdomen, to this is added,

(2) Splanchnic, 40 c.c. of 0.75% novocain, introduced into the retroperitoneal space between aorta and vena cava, as soon as the (upper) abdominal incision is made,

(3) In the case of nervous patients, open chloroform sufficient to make the patient sleepy but not "under," and still able to answer questions.

For lower abdomen, 2½ to 3 c.c. of 4% novocain, made up by withdrawal of spinal fluid to 8 or 10 c.c. and re-injected; slight chloroform towards the end of the operation.

Note.—The present reviewer has found that if a patient is allowed as full a diet as possible up to

16 hours before an abdominal operation, there is no risk of chloroform—liver complications, which seem to be caused only in those patients who are half-starved when they reach the operating table. Carcinomas of stomach and similar cases who cannot digest food should be given glucose intravenously as pre-medication.

T. H. S.

## Capsulectomy for the Relief of Flexion Contractures of the Elbow following Fracture

(From the Journal of Bone and Joint Surgery, Jan. 1944, Vol. XXVI, No. 1.)

Philip D. Wilson in his article has dealt with the various aspects of the injuries in the elbow joint causing later disabilities of which the most important is the limitation of movement. He has found that fibrous thickening and contracture of the capsular ligament is a primary cause which was responsible for the loss of extensibility. After discussing the various pathological considerations of various fractures in relation to limitation of motion, such as supracondylar fractures, intercondylar fractures, fractures of the olecranon and fractures of the head and neck of the radius, he has described his initial experience of a case which gave him the insight into the cause of limitation of extensibility. This was in a case of Volkmann's Ischaemic contracture after a supracondylar fracture. He opened the elbow joint by antero-lateral incision between the brachioradialis and brachialis after retracting the radial nerve. He found in this instance, along with the projecting diaphysis, thickening of the anterior capsule of the elbow with fibrous bands passing into it from the space below the bony projection on the ante-

rior surface of the shaft just above the joint. He excised the bony projection together with as much of the anterior capsule ligament as could be reached and effected "Z" like lengthening of the biceps tendon and he found at the end of the operation the elbow was free for extension. The range of extension was satisfactory though the radial nerve was found under great tension and was found paralysed subsequently.

The follow up of this case showed recovery of the radial paralysis with a remarkable range of improvement in the function of the elbow. This success prompted him to pursue this type of operative procedure in 6 more cases with benefit in 4 cases. There was radial paralysis in two and radial and median paralysis in one of the four successful cases. He had used a tourniquet to control the bleeding in all these cases and this probably accounted for the high incidence of paralysis after operation.

M. G. K.

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### The VI Annual Meeting

The Vth Annual Meeting of the Association was held at the K. E. Medical College, Lahore, on the 30th, 31st December, 1944 and 1st January, 1945 and was, as usual, a great success. Dr. R. N. Cooper of Bombay presided and Rai Bahadur Dr. G. D. Kapur was the Local Secretary. He was helped by a Reception Committee with Lt.-Col. G. S. Chawla as Secretary. All arrangements were made for the comfort of the visiting members and the thanks of the Association are due to the Medical profession in Lahore for their efforts towards the success of the Session. One very welcome feature of this Session was the presence among us of Col. I. S. Ravdin and some of his Colleagues from the American Army Medical Services and a few Doctors of the Chinese Air Force. Col. Ravdin addressed us on "Some Nutritional problems of the Surgical patients" and was also the bearer of greetings from the American College of Surgeons, the American Surgical Society and the College of Physicians of Philadelphia. We wish to record our appreciation and reciprocation of this expression of good feeling from our Colleagues across the Seas and hope that, in the near future, a closer contact would be established between our Association and Sister Associations in the United States, Canada and Great Britain.

An Exhibition of Surgical Instruments was arranged in the Staff Reading Room and formally opened by Mr. A. P. Taylor Gill.

The formal inauguration of the Conference took place in the Lecture Theatre attached to the Patiala Block of the Medical College. Dr. G. D. Kapur welcomed the members and Sir Bakshi Tek Chand, M.A., LL.D., declared the Conference open. In his speech he referred to the part Surgery has played in the fight against disease. He referred to problems such as research and education and the part a body like an All-India Association of Surgeons can play.

The President, Dr. R. N. Cooper, then delivered his Presidential Address:—

I am deeply thankful to you for granting me the privilege to serve this Association of the Surgeons of India at its Sixth Annual Conference in this historic city of Lahore.

The future of Surgery in India is at all times the concern of this Association. Let us therefore make more of this Annual Conference than we have done so far. Let us not just meet once a year and discuss a few subjects of technical interest but also put our heads together and plan for the future. A genius may give a lead in any field of work but continued progress depends on two essential requisites—wise planning and a well worked out organisation. If India is to find her legitimate place on the Surgical map of the world and regain its pristine glory we must plan ahead for the development of the science and practice of Surgery.

A wise lead was given by Dr. Joshi, our Presi-

dent of the last year when he stressed the importance of a Central Library.

After the war there is going to be a lot of post-war reconstruction. England, America and other countries have some schemes for planning the future of the medical curriculum. A sort of enquiry was recently started by the (Bhore Commission) Government of India eliciting the views of a few individuals about the planning of a basic curriculum of medical studies extending over four years. The idea behind it is to supply sufficiently trained medical men in sufficiently large numbers to this country. Mass production in industry and education are fundamentally different. The implications of such a plan have to be carefully considered. This question is of fundamental importance and I feel sure, that I am voicing your opinion, when I state that a hurried and a lightning tour conducted by a Commission without any systematic plan of eliciting the opinion of the profession was not the best way of going about.

After working as a teacher in Surgery for twenty-two years I feel that our curriculum of medical studies needs complete overhauling particularly from the stand point of Surgery and its allied pre-clinical subjects of Anatomy and Physiology.

I also feel that the assessment of a student's knowledge of his subject as ascertained by our examinations is hardly satisfactory. A student should be judged from day to day with regard to his capacity for work, originality and intelligence by his teachers and a confidential record kept. The accumulated reports should be given sufficient weightage at the final examination. In America at the Johns Hopkin's University fifty per cent. weightage is given to such a report at the time of graduation. But I am not unconscious of the fact that there are many more teachers and professors there, than can be found in our institutions.

"I wish, however, to concern myself with the question of studies and not the examinations.

Our present curriculum of medical studies is the result of the labours of those who have preceded us as also those who are our contemporaries. With the best of intentions the curriculum was mainly based on that of the London University under the direction of the General Medical Council of Great Britain. The curriculum as originally conceived was not perfect but was practical and workable. However, those of our friends who guide our destinies in the Universities and the Medical Council of India have been so enthusiastic "to go one better" than the original London plan, that in course of time a curriculum is produced which defeats its own object.

I admit, that if ten medical men were to meet and discuss the question of the medical curriculum, at least twenty different suggestions would be made. Some would like to shorten the pre-admission course and others would be prepared to

do the opposite and add for instance Logic as a subject. Some will be for shortening the pre-clinical course and simplifying the course in Anatomy and others will wish to add comparative Anatomy as a definite test. The case will become still more difficult when the relative values of Medicine, Surgery, Midwifery, Pathology, etc., are discussed. There will be a plethora of suggestions. In fact the permutations and combinations of the resulting suggestions would be bewildering; and each mover of a suggestion would be so convinced of his arguments that a minor war may result. However, having imbibed the principle of non-violence, compromises are accepted. This principle works out somewhat on these lines. A certain stalwart wishes to augment the existing curriculum in a certain subject. He knows that the only way he can carry his argument through, would be to enlist the support of other members by promising his support to them when they stand up to suggest improvements and additions to their favourite subjects. By some such process a Curriculum has been evolved which is overloaded and impractical. It is my honest conviction that no student of ordinary intelligence can hope to encompass the whole curriculum for the final M.B., B.S. examination within the period of time allotted to it and hope to pass the examination at the first attempt taking into consideration the high standards of examination now prevailing. The present curriculum seems to be evolved for the super-student. Even the poor super-student gains width at the expense of depth. The time has come to cry "Halt." The present curriculum needs overhauling with a distinct emphasis on shortening and simplifying it.

A young medico entering general practice can conveniently afford to forget 90 per cent. of the Surgery, Midwifery and Ophthalmology that he has learnt. Is it really necessary to compel him to learn these subjects at such length as he is now made to do and also submit him to a gruelling test in the bargain? Now that various post-graduate degrees and diplomas are available a medico who wishes to embark upon the career of a specialist can afford to undergo a real post-graduate training after his graduation.

I have no wish to inflict on you a detailed curriculum, such as I would favour. I would certainly suggest that the teaching in Anatomy and Physiology should be simplified. All unnecessary details about the minute branches and ramifications of an artery or nerve should be omitted except in so far as they may have a bearing on medicine. The examinations as now conducted are just tests of a student's capacity to remember facts. As soon as the examination is over the student soon forgets almost all that he has learnt so that his brain should be ready to store some more facts and figures about his future subjects of study. He has to wade through some thousands of pages of printed matter and is so overburdened with lectures that he has no time to think for himself. He is ever-ready to quote "so and so" in support of

any statement that he makes, but never stops to think or argue for himself. He fails to apply the critical attitude to any statement that he reads in any periodical or a book. For graduate training the curriculum in Surgery should be so reduced as to constitute just "Basic Surgery."

For the progress of Surgery, we are not so much concerned with the undergraduate as we are with the post-graduate studies. It is in this direction that I would like this Association to make itself heard to the powers that be. Here I would like to strike a warning note against copying or imitating the London pattern. Unless we are prepared to change our plans in keeping with the times, we shall never make real progress. For instance the heyday of Surgery in Vienna has passed. I shall not enter into the causes of its downfall.

Surgery in England and Scotland has for a long time stood on a high pedestal. But failure to recognise the changing trends and a foolish sense of pride in conservatism will lead to the decline of the prestige of British Surgery. This is, however, the Britisher's problem.

America as a go-ahead country has to my mind outstripped England in many branches of Surgery. Some of the American centres of medical education are, in my eyes, the veritable Mecca of Surgery. It is to this country that we will have to turn for inspiration and guidance in our future planning. Such a planning should include the consideration of the following points:—

- (1) The provision of facilities for post-graduate study of Surgery with particular emphasis on Anatomy, Physiology, Pathology and Research.
- (2) An extension of period of post-graduate study to a minimum of seven years.
- (3) The provision of graded appointments in every teaching Hospital.
- (4) The standardisation of hospitals with particular regard to Case-records and Research.
- (5) The establishment of Staff Meetings.
- (6) The selection of suitable recruits to Staff appointments.
- (7) The establishment of a College of Surgeons, a Library, a Research Laboratory and a Museum.

Facilities for post-graduate study in Surgery are lamentably lacking in almost all our Colleges and Hospitals. In most of the institutions a student after his graduation is left to shift for himself. In Bombay in the K. E. M. Hospital we have now organised a course in post-graduate Surgery. Experience will lead us to modify this attempt so that the post-graduate will not only receive a certain amount of coaching but will also be made to think for himself. Our present M. S. examination is so planned that the student fails to appreciate the value of Anatomy and Physiology in relation to Surgery. For the Fellowship examination of

London at least there is a primary examination in Anatomy and Physiology. But by the time the candidate appears for the final examination Physiology is laid on the Shelf. There is some attempt at including Anatomy in the M. S. examination, but I have never seen any attempt either in India or England to include physiology in this examination. The study of Anatomy is helpful in bringing precision to Surgical technique. But it is the study of physiology that gives us the true insight into the Scientific and Research side of Surgery. To my mind this is the rock on which the Ship of Surgery has foundered both in this Country and in England.

There is an attempt made in some Universities to encourage a student to think for himself by demanding of him a thesis for the examination. It is a step in the right direction in some respects only. The student is handicapped for want of a good reference library. As an examiner I have been able to see for myself how this thesis writing works out in actual practice. The student as he works hard at his thesis is apt to neglect the clinical aspect of Surgery. A candidate who has submitted quite a good thesis which embodies some originality of thought, makes a very poor show at the clinical examination.

(2) The obvious remedy lies in lengthening the period between the qualifying examination and the Mastership examination. This period should be at least seven years. At present the University Regulations permit a medical graduate to appear for his Mastership within two years. This rule still prevails in London. I plead guilty to having passed my Mastership in London two years after my graduation. I now shudder to think of it. However, that was nearly a quarter of a century ago. In the last twenty-five years Surgery has made such enormous strides in all its branches that proficiency in Surgery amounting to Mastership is unattainable within two years. Besides, let us study his training. After graduation he probably holds an appointment for six months as a House Surgeon. Depending upon the routine of the Hospital and the liberality of his chief he may be given a few opportunities to perform a few of the routine operations. After his appointment as a House Surgeon in the majority of cases he is left to shift for himself as best as he may.

(3) If the period of post-graduate study be increased it is essential that graded appointments be established in every teaching hospital. This Association must exert itself in this direction. In Bombay at the K. E. M. Hospital a newly qualified graduate works as a House Surgeon at first. If his work is satisfactory he may be appointed as a Casualty Officer, as a House Surgeon in one of the specialities and finally as a Registrar. The last post he may hold for as long as three years. Thus the future candidate for Mastership remains in continuous touch with clinical and practical Surgery for over five years. This plan does not give the candidate a chance to be scientifically minded.

With this end in view it has been now suggested to the Dean of the K. E. M. Hospital to throw open a post in Pathology extending over a year so that a post-graduate will begin to have a true perspective from the scientific point of view. Such a plan was first evolved at the Johns Hopkin's University and was afterwards accepted, elaborated or modified by other Centres. The importance of Pathology to Surgery cannot be overemphasised. The American College of Surgeons demands that a candidate for Fellowship should produce a complete and exhaustive record of a hundred cases under his care. A Registrar during his tenure of office may apply himself in this direction. You will, I hope, agree with me that it is only by a prolonged apprenticeship that a suitable candidate will develop the proper attitude of a research worker, an original thinker and a practical technician. These graded appointments should be so remunerated as to enable the post-graduate to keep the wolf from the door.

(4) A candidate for a post-graduate degree cannot produce his record of 100 cases unless a drastic change is made in the matter of keeping Case Records. Certain standards will have to be maintained in this respect by all teaching Hospitals. This Association must exert itself in this direction and demand that Case Records be kept in a standardised form and that adequate facilities for Research be provided and regular staff meetings be held.

(5) Once a practitioner is appointed to the senior staff of a Hospital he is apt to lose his keenness for further Scientific Study. These staff meetings, where attendance is compulsory by the staff, will keep the different members sufficiently keyed up to maintain the prestige of their own department. In Bombay at the K. E. M. Hospital we have made a modest beginning in this direction. These staff meetings are also open to members of the Resident Staff. In fact these junior officers are encouraged to present a short paper and take part in the discussion so that the senior members of the staff may make a note of the youngster's capability, his powers of expression, his conduct and demeanour. Such observations prove really helpful towards recruitment to the Honorary staff.

(6) In fact all appointments to the senior staff should involve all these considerations. The system now prevailing in most of the Government Hospitals results in the appointment to the post of an Honorary of some one who happens to catch the eye of the Surgeon-General or the Minister. The appointment involves such considerations as those of caste, creed, religion and politics. This system introduced by an alien Government has been, sad to say, perpetuated and even accentuated by some of our local ministers. It is up to us and to the public to demand that appointments to public posts involving considerations of the life and the health of a nation should be determined by efficiency alone.



(7) It may be too much to expect our hide-bound Universities to institute such changes as I have indicated in the regulations of the Mastership examination. The remedy lies in our own hands by taking up the suggestion of our first president Col. Pandalai and starting a College of the Surgeons of India. Such a College can truly function when we have a truly national Government. The Diploma granted by such a College should be worthy of the aims of our Associations and of this great country. The establishment of such a College with a Research Laboratory, a Library and a Museum attached to it is within the bounds of possibility in the near future, should the hopes held out by one of our members Dr. Chandrachud of Baroda come to fruition. You cannot hope that all help should come through the public. God helps those who help themselves. If you hope to win the verdict from posterity that you have done your duty, you must be prepared to contribute your mite by delving deep into your pockets. Sacrifices will be required. Your willingness for sacrifices will, for all time, be the true measure of your sincerity for progress.

Discussions on the three main subjects fixed for this year were held in the afternoon and the following days. The discussions were, as usual, prolonged and the shortage of time was keenly felt.

Lt.-Col. V. Goldman read a paper on "The place of the Anaesthetist in the Surgical Team." The paper was very much appreciated and, towards the end, Col. Goldman answered a few questions.

Col. I. S. Ravdin of the American Army Medical Service, delivered his very illuminating address on the Nutritional Problems of the Surgical Patient" on the 31st of December. This, and Col. Goldman's paper are published in full in this issue of the Journal.

Col. Ian Fraser's address on "Penicillin" on the same day was a complete and masterly exposition of all that is known up to the present day about this new drug.

There was also a film on "Oxygen Therapy" and a talk on the manufacture of Surgical Catgut in India by Lt.-Col. R. H. Malone.

Demonstrations of Operations had been arranged in the Mayo and Ganga Ram Hospitals and members had the opportunity of watching a Prostatectomy, Radical Mastectomy, Nephrolithotomy and other operations.

Visits had also been arranged to the Surgical Works of Gulam Nabi and Sons, where the delegates were entertained to tea and to Jehangir's Tomb at Shahdara.

The usual Annual Dinner of the Association was held in the King Edward Medical College Hall and it was a grand affair. The Chief Guest of the evening was the Hon. Chief Justice Sir Arthur Trevor Harris. Included among the Guests were also Col. I. S. Ravdin and some of his American Colleagues. The toast of the King Emperor was proposed by the President. Col.

Mirajkar in a short speech proposed the toast of the Chief Guest and in his reply Sir Arthur referred to the rapid progress made in Surgery during the last twenty or thirty years. He emphasised on the need for extending Surgical aid to the villages. He appreciated the presence of the American Surgeons and hoped that it would lay the foundation of a closer co-operation between various Surgeons working in different parts of the World. Col. Ian Fraser, Consulting Surgeon to the Middle Command proposed the Toast of the "Association of Surgeons of India." The President, in his reply, briefly traced the birth and subsequent growth of the Association and explained its aims and objects. The Secretary, in expressing, on behalf of the Association, its thanks to the Reception Committee paid a tribute to the excellence of the arrangements made by the Committee.

### The Annual General Body Meeting

The Annual General Body Meeting was held at 5-30 p.m. on 1-1-1945 with the President Dr. R. N. Cooper in the chair. More than 60 members were present. The Secretary read the Annual Report of the year ending 31st December 1944 and the Minutes of the last General Body Meeting, and they were passed.

The Secretary proposed the name of Col. V. R. Mirajkar of Lahore for the Office of the next President and he was unanimously elected.

Dr. M. G. Kini proposed that a whole-time Steno-typist on a salary not exceeding Rs. 80 per mensem be appointed at the Central Office. Seconded by Dr. Nigam, this was unanimously passed.

A resolution authorising the purchase of a Micro-reader was put to the vote and declared lost.

Dr. A. V. Baliga proposed and Dr. S. R. Joglekar seconded that a Library Committee be formed for the purpose of collecting Funds and books for the Library. The following members were elected for the purpose.

S. G. Joshi—Bombay  
H. K. Sett—Calcutta  
Miss N. R. Mucadam—Delhi  
B. N. Balakrishna Rao—Mysore  
Dr. Udham Singh, Lahore  
Tulsi Das—Amritsar  
M. D. Patel—Ahmedabad  
M. K. Parikh—Ludhiana  
V. L. Suryavanshi—Sholapur  
H. L. Vaidya—Kathiawar  
K. S. Nigam—Lucknow  
C. L. Modi—Hyderabad  
P. A. Menon—Trichinopoly.

The Secretary then informed the Meeting of the invitation from Mysore to hold the next Annual Meeting in Mysore, and it was decided that the invitation be accepted. Dr. B. N. Balakrishna Rao was elected as the Local Secretary, and the

Meeting is to be held during the Xmas holidays, 1945.

The President then moved a resolution of condolence on the sudden demise of Rai Bahadur Dr. N. P. Srivastava of Nagpur and Col. Hayes, and the resolution was passed, all the members standing. Col. Hayes, though not a member of the Association, had done a considerable amount of work towards making arrangements for the Lahore Session.

The Editorial Board Meeting was held with Dr. R. N. Cooper as President in the absence of the Chairman, Lt.-Col. K. G. Pandalai. Dr. V. R. Khanolkar was elected to the Editorial Board under the proposal of the Editor. The task of making of abstracts from other Journals was distributed among a few members.

As there was a sufficient number of subjects for discussion during the succeeding three years, no new subjects were chosen.

The meeting terminated with a vote of thanks to the retiring President by the Secretary. He expressed, on behalf of the Association, its appreciation on the able way in which Dr. Cooper had conducted the affairs of the Association during his term of Office.

The Governing Body met again soon after the General Body Meeting and admitted a few more new members and also elected Dr. B. M. Sundaravadanan of Madras to fill up the vacancy created by the election of Col. Mirajkar as President as per Resolution passed at the Governing Body Meeting held on 28th December, 1939.

#### Registry of Sarcoma of Bone

It was decided at the last Conference that a Registry of Sarcoma of Bone is to be maintained under the auspices of the Association. Dr. V. R. Khanolkar of the Tata Memorial Hospital, Bombay, has very kindly consented to make the necessary Pathological study of Specimens. All Surgeons are, therefore, requested to send short but complete notes of cases of Sarcoma of Bones under their care to Dr. Khanolkar along with X-Ray and Clinical photographs, if any, and a piece of embedded tissue or two unstained slides. It is particularly requested that all Surgeons will co-operate in this endeavour.

#### The Library

The attention of all members is invited to the Circular regarding the Library. A separate account has been opened and donations and subscriptions may be sent to the Secretary. Suggestions regarding books and journals to be acquired are welcome. Donations will be acknowledged in the Journal from time to time.

#### List of Donors

	Rs.
R. N. Cooper, Bombay	500 0 0
S. R. Joglekar, Bombay	500 0 0

N. C. Joshie, Delhi	500 0 0
Col. K. G. Pandalai, Madras	100 0 0
N. Mangesh Rao, Madras	100 0 0
T. Kanakaraju, A. B. P. O.	100 0 0
V. G. Vaishampayan, Sholapur	100 0 0
M. G. Kini, Madras	100 0 0
P. Rama Rau, Madras	100 0 0
Col. A. T. Andreasen, Rawalpindi	100 0 0
Kedarnath Sharma, Delhi	100 0 0
N. R. Mucadam, Delhi	75 0 0
N. A. Aiengar, Mysore	60 0 0
K. M. Rai, Madras	50 0 0
H. D. Gandhi, Bombay	50 0 0
V. L. Suryavanshi, Sholapur	50 0 0
T. H. Somervell, Neyyoor	22 0 0
Balance in Hyderabad Conference (Excursion to Ellora & Ajanta)	510 0 0
Reception Committee Contribution	340 0 0
<b>Total</b>	<b>3457 0 0</b>

#### Subjects for Discussion

##### 7th Meeting :

- Traumatic Surgery of the Skull—*  
Opener : Dr. R. N. Cooper, Bombay.  
Seconder : Dr. G. D. Kapur, Lahore.
- Enlarged Prostate—*  
Opener : Dr. S. R. Moolgavkar, Bombay.  
Seconder : Dr. S. S. Anand, Lahore.
- Fractures of the Neck of the Femur—*  
Opener : Dr. B. N. Sinha, Lucknow.  
Seconder : Dr. A. K. Talwalkar, Bombay.

##### 8th Meeting :

- Carcinoma of the Rectum—*  
Opener : Dr. C. P. V. Menon, Madras.  
Seconder : Dr. E. J. Borges, Tata Memorial Hospital, Bombay.
- Carcinoma of the Cheek—*  
Opener : Dr. B. M. Joly, Delhi.  
Seconder : Dr. K. M. Rai, Madras.
- Hare Lip and Cleft Palate—*  
Opener : Dr. S. C. Sinha, Calcutta.  
Seconder : Dr. M. G. Kini, Madras.

##### 9th Meeting :

- Bone Tumours—*  
Opener : Dr. D. R. Meher Homji, Bombay.  
Seconder : Dr. M. G. Kini, Madras.
- Intracranial Tumour—*  
Opener : Dr. A. V. Baliga, Bombay.  
Seconder : Dr. R. N. Cooper, Bombay.

## 3. Burns—

Opener: Dr. M. R. Munawar Ali,  
Hyderabad.

Seconder: Dr. G. M. Phadke, Bombay.

## Prize Essay

The offer of a prize of Rs. 150 for the best Essay on "Infections of the Foot" is renewed. The following are the conditions:—

1. The competition is open to all qualified medical practitioners registered in India, who have been in practice for not more than 10 years after qualification.

2. The essay should be based on original work and should be written in English.

3. It should be type-written on one side of the paper only and should not contain the name or other indication of the identity of the competitor. Four copies should be submitted.

4. The name, address and qualifications, however, should be written on a separate sheet of paper and enclosed with the essay.

5. The subject is "Infections of the Foot" and the essay should reach the Secretary before the 1st October 1945.

6. The copyright for the winning essay will remain with the Association of Surgeons of India and will be published in the Indian Journal of Surgery. Other essays will be returned to the senders, if accompanied by stamped addressed envelopes.

7. The Governing Body may, at its discretion, withhold the prize if the essays submitted do not come up to the standard.

8. All communications regarding the above are to be addressed to the Secretary, Association of Surgeons of India, 'Binfield,' Kilpauk, Madras.

C. P. V. MENON,

Hony. Secretary.

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# THE INDIAN JOURNAL OF SURGERY

Vol. VII

JUNE 1945

No. 2

## URINARY CALCULI

by L. B. JOSHI, M.B.B.S. (Bom.), F.R.C.S. (Eng.).

The history of urinary stones is as old as that of human beings. The chemical compositions of stones of antiquity and of those of to-day are unchanged. Knowledge about the aetiology of urinary stones is, however, still incomplete, leaving a great deal of scope for research. If the problem of urinary stones is solved it would go a long way towards solving the problem of other stones in the body.

A brief account of the applied Anatomy and Physiology of the problem may not be out of place. The nephron or uriniferous tubule is 20 to 40 u in length. Each kidney contains one million of these units. The total filter area of the two million glomeruli comes to well over one square foot. Normally the output of urine for 24 hrs. is given as 1500 C.C. i.e. 62.5 C.C. per hour. However, about 1200 C.C. per hour is the maximum excretion possible. Thus ordinarily only 5% of the kidney tissue is working at any moment. In animals three-fourths of the kidney tissue has to be removed before the blood urea rises, showing inadequate kidney function.

Certain teleostean fish have kidneys which are aglomerular i.e., without the presence of glomeruli and all the urine is secreted by the tubules. It is probable that the first convoluted tubules in human beings also perform a similar function. Specialization of certain cells or tissues make their functions more specific and limited. In the first convoluted tubules there is only one type of cell, cuboidal, with abundant mitochondria tending to get arranged in longitudinal rows. The cells have a non-vibratile brush border edge. This structure is suggestive of secretory activity. How can one accept without reserve statements made that these cells

perform many functions such as re-absorption, secretion, formation of hippuric acid, ammonia and phosphates? Blood returning from the glomerulus and the urine from Bowman's capsule are physically balanced and any further exchange between these fluids without definite cell activity is impossible. Most probably the 1st convoluted tubules actively secrete the colloids, acids and certain organic matters which cannot be filtered by the glomerular filter. The whole structure of the nephron is suggestive of a flush system. The ample fluid from the Bowman's capsule washes down the solids secreted in the first convoluted tubule.

The loop of Henle gets fresh supply of blood and again physical exchange between the urine in this part of the tubule and the fresh blood is possible. The flat cells of the descending loop of Henle are similar to those of the capsule and permit physical exchange. Re-absorption takes place in the descending loop of Henle. The structure of the mucosa of the 2nd convoluted tubule is very similar to that of the 1st convoluted tubule, but the brush border edge is not seen and the mitochondria are more definitely arranged in lines more perpendicular to the basement membrane. It is stated that the loop of Henle and 2nd convoluted tubule have similar functions. The structure of the descending loop of Henle is very different from that of the ascending part of the loop of Henle and both are different from the structure of the 2nd convoluted tubule. It appears to be obvious that each of them must be performing different functions.

In corrosive sublimate poisoning, it is the ascending loop of Henle and the convoluted tubule (probably second) that show necrosis,

The uriniferous tubule is the basic unit of the urinary system. Not enough is known about its physiology. The formation of urinary calculi must be due to some fault in the working of this unit.

A number of pigments and solids get deposited in the kidney under various circumstances, as shown in the following table.

Pigment or deposit.	Site where lodged.	Disease in which these are seen.
Blood.	Convolute tubule.	Destruction of Haemoglobin e.g. pernicious anaemia.
Bile.	Convolute tubule.	Jaundice.
Bilirubin infarct.	Apices of Pyramids.	Jaundice.
Melanin deposit.	Loop of Henle.	Melaninuria.
Glycogen deposit.	Loop of Henle.	Van Gierk's disease. Severe diabetes.
Uric acid infarct.	Yellow streaks at apices of Pyramids & deposits in collecting tubules.	In new born babies.
Calcified necrotic submucous patches.	Loop of Henle and convolute tubule.	Corrosive sublimate poisoning.
Casts.		Nephritis.

The insoluble deposits and casts in this list are the seeds of the stones that form later.

Though the problem of the aetiology of urinary stones is complex, there are certain general observations which help a great deal in the investigations.

### THE STONE WORLD

Urinary stones occur in human beings all over the world but in certain regions they are extremely common, in others not so frequent and in still other parts they

are very rare. Urinary stones are common in China, Northern India, Persia, Arabia Mesopotamia, Palestine, Dalmatia, the Volga Valley, the Balkans, Parts of France, Egypt and parts of England especially Norfolk. In North America Urinary stones are uncommon; cases are seen in certain regions of South California and South Florida.

In Germany, Austria, Czechoslovakia and Hungary the incidence of Urinary stones has of recent increased remarkably due to economic distress.

Full-blooded Eskimos are almost immune from Urinary calculi; yet, in Iceland the condition is prevalent among the Scandinavian population. In South Africa the native population of Johannesburg does not suffer from Urinary stones whereas the condition is tolerably frequent among the white people of the region (Johannesburg Med. Annual 1937).

To understand the cause of the above distribution further study of each region is essential.

### DISTRIBUTION OF STONE IN CHINA

There are two outstanding centres.

(1) In the South, around the Canton area extending South-West to the City of Fatsan and to the South-East to the city of Tung kun. It is confined to the delta of the West River (SIKIANG RIVER).

(2) Hwaiyan in Anhwei province. There are two other centres of importance.

(1) In the Southern parts of Central Hunan with Shaoyang as a important centre but extending South to Lingling.

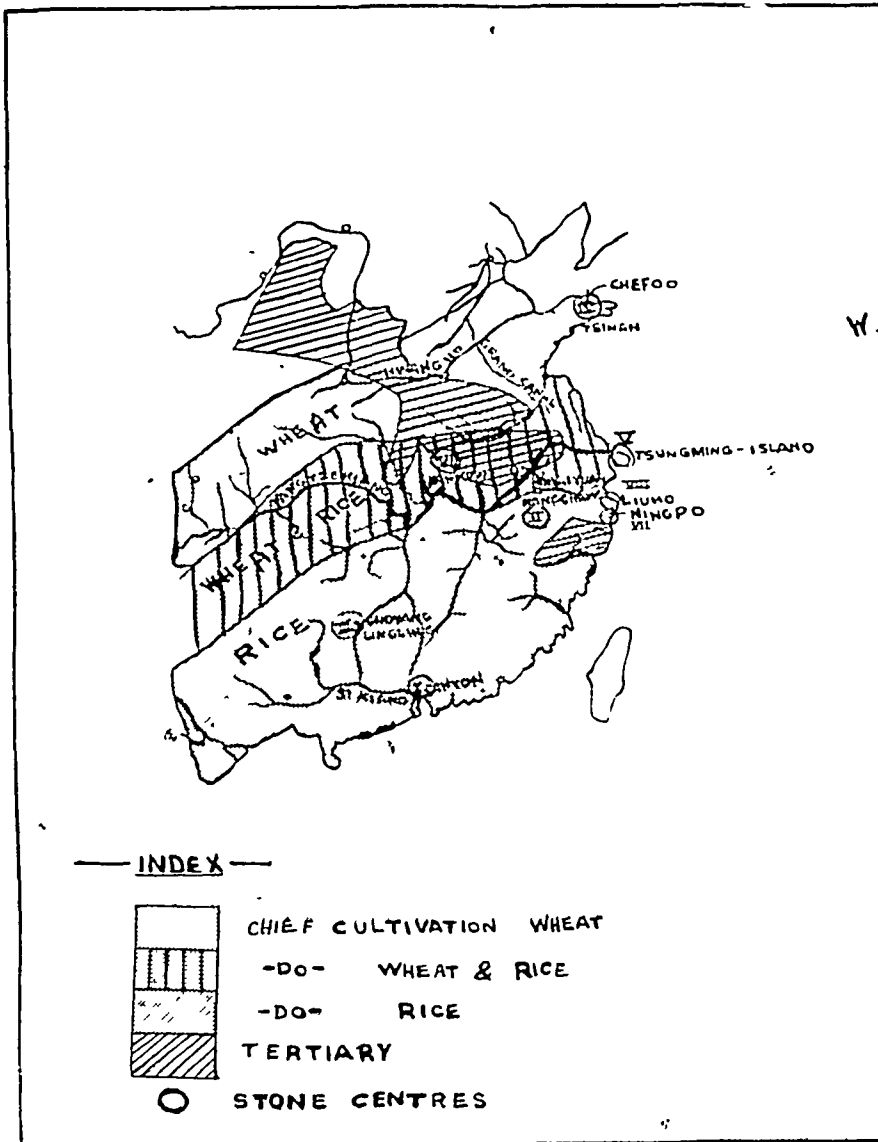
(2) In Shangtung province it covers the whole of the eastern part of the province probably centering in Chefoo with a second centre in Tsinan.

Small areas affected are :—

(1) In Hupeh mainly North-West of Hankow.

The author is indebted to the Govt. of Chungking, China, for information about their country.

# MAP OF CHINA



- (2) In Chekiang in Ningpo district.
- (3) In Kiangsu near Linho.
- (4) In the Island of Tsungming.

Rare cases occur in :—

Kwansi, Fukien,

In the north & the west of China in Yunan and Manchuria.

The statement that Urinary stones are common in China is not quite true. In that country the disease is very common in certain areas and is rare in certain other parts.

Further minute study of a region is required to explain the exact geographical distribution and it was possible to do so with regard to our country.

## INCIDENCE OF STONE IN INDIA

References regarding the incidence of stone are made in the early Gazetteers of India, but the information is so scanty that it is not possible to draw even a vague map of the stone incidence of the time.

In 1894 at the first Indian Medical Conference Capt. Roberts read a paper on "*Vesical calculi in India*". The figures quoted by him are as under :—

Province.	Population in millions.	Annual stone operations.	Ratio of cases per 1000 of Population.
Punjab	19 Millions	1,482	0.078
N.W.F.P. & Oudh	45 "	925	0.017
Bombay	16½ "	283	0.017
C.P.	9¾ "	112	0.011
Bengal	69½ "	218	0.0034
Madras	31 "	21	0.00087
Assam	4¾ "	Nil	Nil

Robert McCarrison studied the same problem during the years 1926 to 1928. Some of his figures are as follows :—

## INCIDENCE OF URINARY STONES PER 1,00,000 OF THE POPULATION

India Generally	.. 10.
Dera Ghazi Khan (Punjab)	.. 438.
Hyderabad (Sind)	.. 266.
Sukkur (Sind)	.. 156.
Manipur (Assam)	.. 84.
Dera Ismail Khan (N.W.F.P.)	.. 62.
Sharanpur (U.P.)	.. 25.
Ahmadnagar (Lower Bombay)	.. 13.
Benares (U.P.)	.. 5.
Sylhet (Assam)	.. 2.8-
Malabar (Madras)	.. 0.3
Kolaba (Lower Bombay)	.. 0

In the present work, the incidence of urinary stone was studied per 100,000 of the population of each district in British India.

Areas or Districts.	Incidence per 1,00,000 of the population
Northern & North-East Punjab, Western Half of U. P. and some districts in the South of U. P., Quetta, Ahmedabad, West Khandesh, Poona, Jubulpore, Calcutta, Chittagong and Manipur.	10 to 25
Most of Southern Punjab on the left bank of Indus and Simla. Most of SIND on the right bank of Indus. Kohat & Peshawar in N.W.F.P., Jhansi in U.P. Nasik in Bombay.	25 to 50
Dadu and Tharparkar in Sind.	50 to 75
Sukkur in Sind.	75 to 100
Dera Gazi Khan in N.W.F.P.	
Dera Ismail Khan in N.W.F.P. } Hyderabad in Sind. }	More than 100

The present figures, the figures for 1894 and those of 1926 look quite confusing. Special maps were drawn for each of the periods stated above showing provinces where the incidence of urinary stone was maximum, where it was moderate and where the incidence was minimum. The maps for 1894, 1926 and the present show a close resemblance. If these maps could have been drawn for the districts or for the natural divisions of India as against political administrative boundaries, the three maps would be exact copies of each other. The few variations seen in the three maps are mainly due to variations in political boundaries.

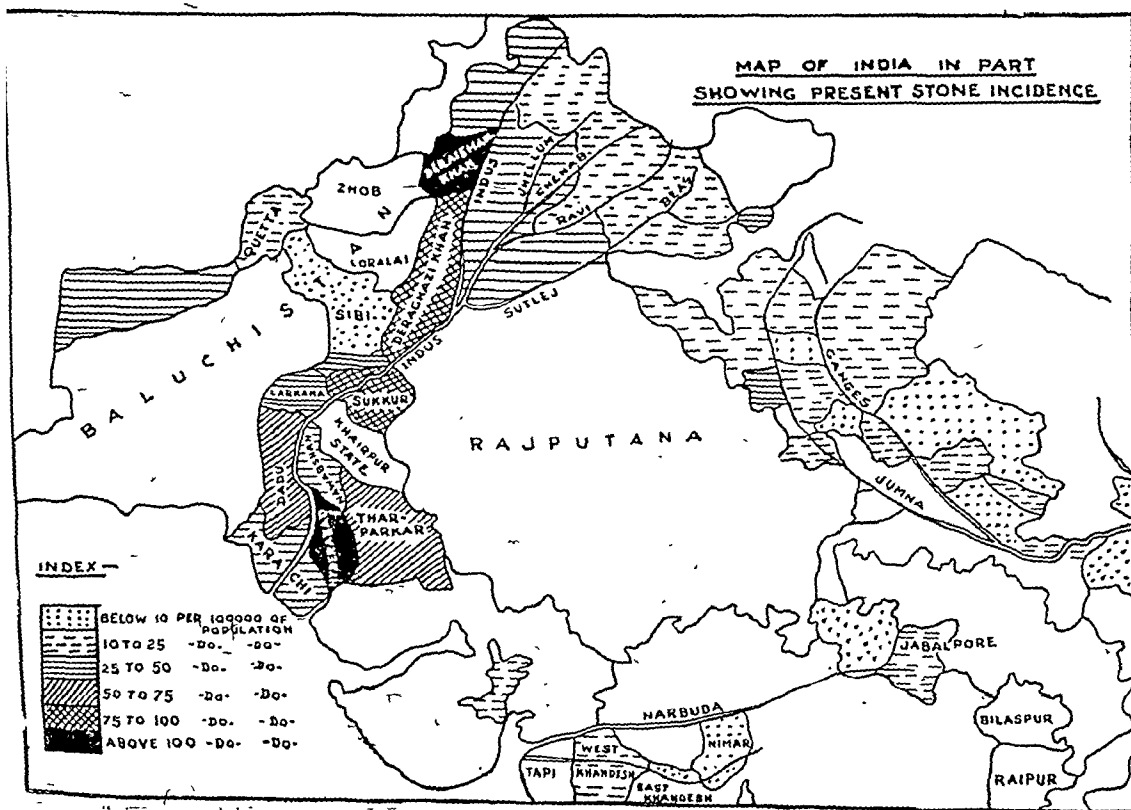
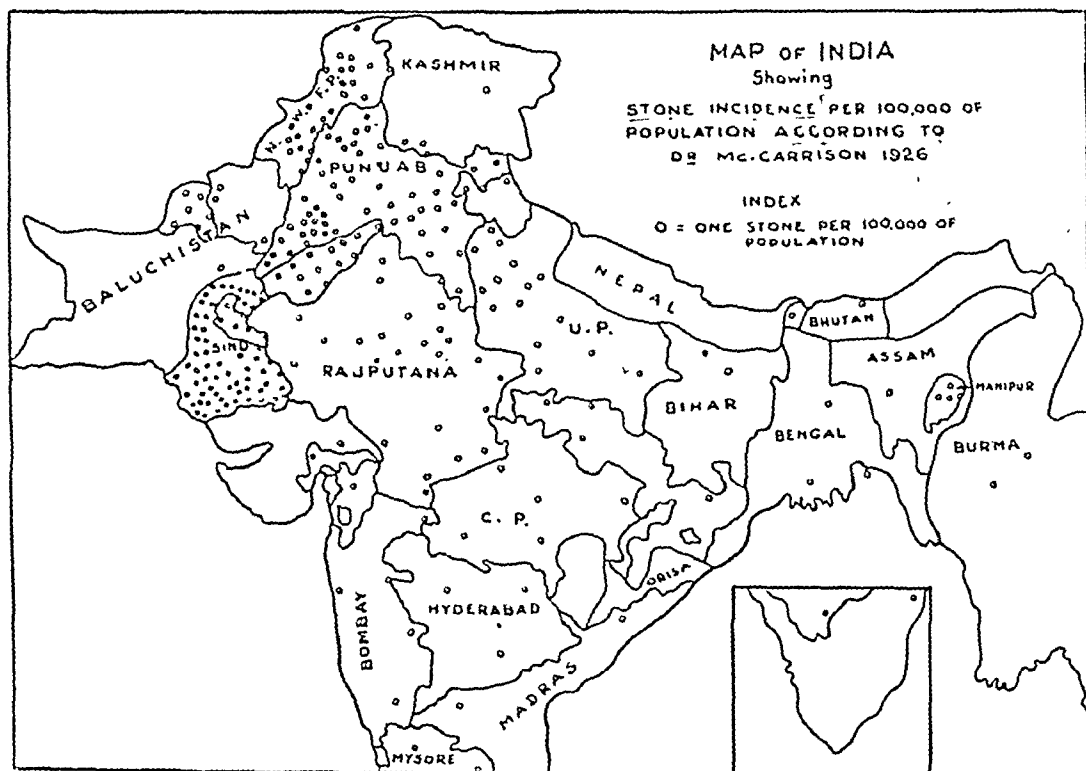
This almost unchanged variation of incidence from one region to another must have some explanation. There is reason to believe that the map of the world showing areas where urinary calculi are common has also remained unchanged.

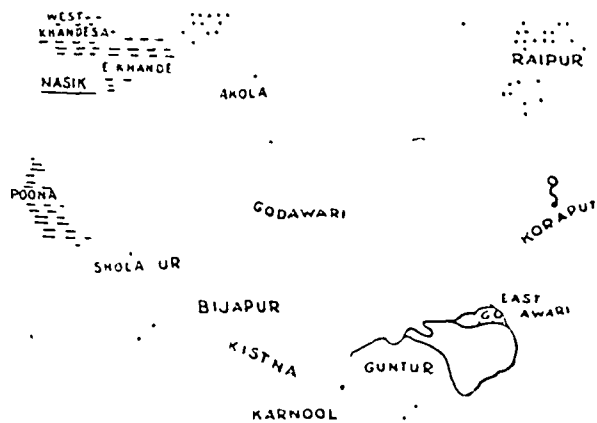
Attempts to reason out this peculiar Geographical distribution have been made by various workers.

## RACE AND RELIGION

That neither the race nor the religion has any bearing on the problem is self-evident from the fact that the urinary stone map of the world covers parts of Asia, Europe, and Africa.



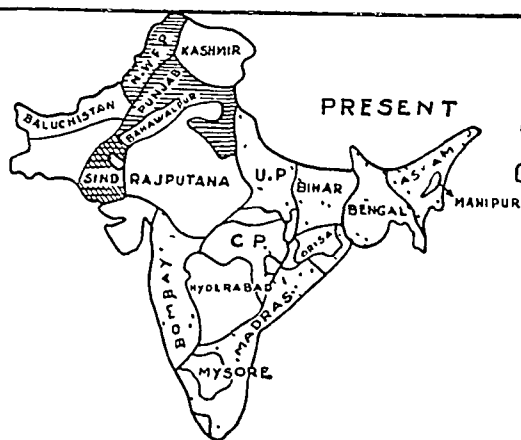




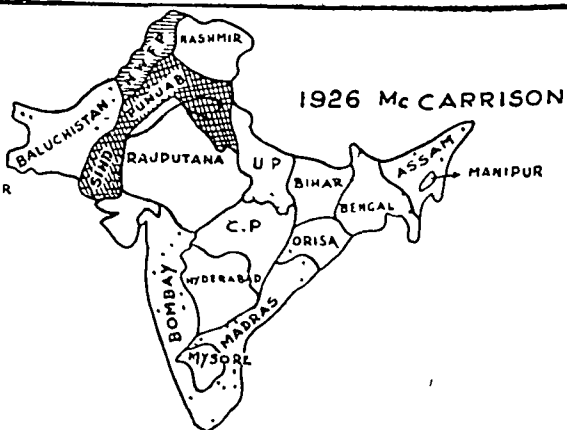
MAP OF INDIA  
IN PART SHOWING  
PRESENT. STONE INCIDENCE

INDEX

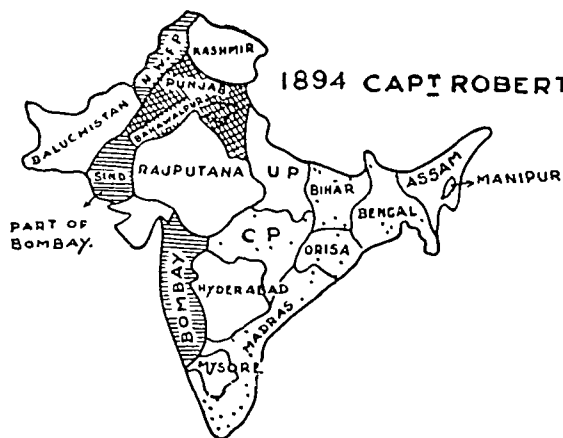
BELOW 10 PER 100 000 OF POPULATION	- DO -	- DO -
10 TO 25	- DO -	- DO -
25 TO 50	- DO -	- DO -



PRESENT



1926 McCARRISON



1894 CAPT ROBERTS

MAPS OF INDIA  
SHOWING  
COMPARISON OF STONE INCIDENCES

INDEX.

LOW INCIDENCE	- DO -
MEDIUM - DO -	- DO -
MAXIMUM - DO -	- DO -

## CLIMATE

A study of the temperature and rainfall maps of India also shows no resemblance to the map of stone incidence.

The district of Nasik with its most pleasant climate has the same incidence of stone as the district of Jacobabad in Sind which is the hottest spot in the whole of India. Parts of the Punjab where the annual rainfall is less than 20" have the same incidence of urinary calculi as Manipur in Assam where the annual rainfall is more than 80".

## VITAMINS

Robert McCarrison stressed the importance of Vit. A as a causative factor in Urinary Calculi. It is fairly certain that the deficiency of Vit. A leads to serious injury to the renal epithelium and this in its turn is probably a cause of the stone.

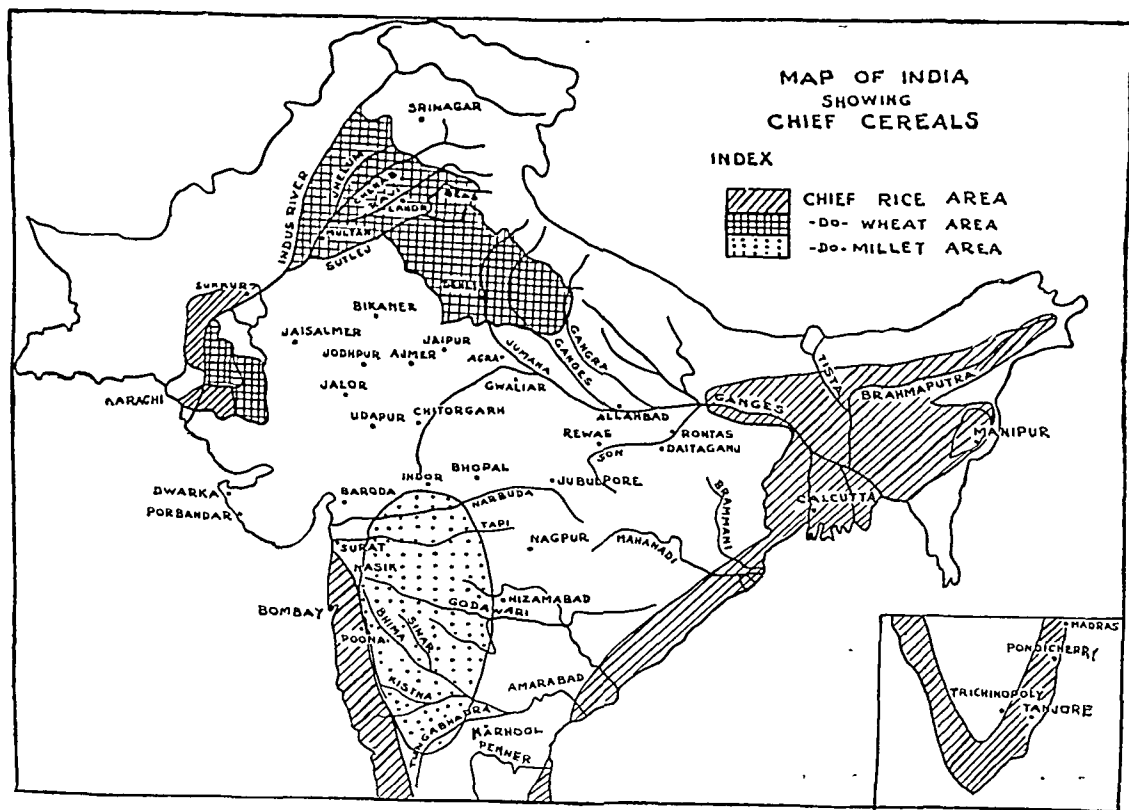
Sind and the Punjab are some of the most fertile provinces in India. Food and milk are plentiful there. The Hari or Farm worker in Sind by practice takes some milk every day. People from Madras and

the Deccan have a poor diet and do not take milk. Yet, strangely enough, the incidence of urinary calculi in the Deccan and Madras is insignificant as compared to that in Sind and the Punjab.

## CEREALS

Both Capt. Roberts in 1894 and Robert McCarrison in 1926 tried to prove that the cereals have a definite co-relation to the incidence of urinary stones in a given area. With the aid of figures available at the time Capt. Roberts showed that the incidence of urinary stone is in inverse proportion to the percentage of the rice eating population of an area.

Province.	% of population eating rice.	Incidence of stone per 100,000 of population
Punjab	5	7.8
N.W.F.P. & Oudh	8.8	2.1
Bombay	12.0	1.7
C.P.	30.0	1.1
Bengal with Bihar	61.0	0.34
Madras	30.0	0.067
Bengal without Bihar	61.0	0.04



It is unfortunate that the data for Sind and Assam were not available. The figures are convincing excepting for the omissions mentioned above.

McCarrison studied the same problem and found that in experiments on Albino rats, cereals showed a definite stone-producing tendency. He arranged cereals in the following order of descending stone producing potency.

1. Whole wheat flour.
2. Oatmeal.
3. Bajra.
4. White flour.
5. Rice
6. Cambu.

According to their stone producing potency, Capt. Roberts also arranged the cereals in the same order viz. wheat, millet and rice.

A study of the composition of the cereals regarding their calorific value, roteins, carbohydrates, fats and vitamins cannot explain the above order. Figures about the ash contents of these cereals are, however, interesting:—

	K	Na	Ca	Mg	P <sub>2</sub> O <sub>5</sub>	SO <sub>4</sub>	Chloride	SiO <sub>2</sub>
Wheat	24.03	9.55	3.5	13.24	16.87	0.01	0.0	8.28
Rice	20.83	13.98	4.48	9.6	43.21	0.24	0.8	6.14
Oats	15.01	4.38	4.09	7.18	24.34	0.48	1.02	42.64

Comparing the figures, we find that wheat contains more of K, Mg. than oats or rice and rice contains the same factors more than oats. Of the three cereals, rice stands highest in sodium content followed by wheat, oats coming last. In the chloride and sulphate content oats come first, rice comes second and wheat is third.

It becomes apparent that the alkaline ash and deficiency of sulphate, chlorides and sodium determine the stone producing potency of cereals.

The above analysis suggests that oats should have less stone producing potency than rice and rice less than wheat. Oats are not used as the main food cereal in any part of India and as such the stone producing potency of oats in comparison

to rice may have to be confirmed again by experiments on rats.

However, cereals and vitamins cannot explain the distribution of stone cases in India. The inhabitants of Manipur (Assam) are chiefly rice eaters and yet they have the same stone incidence as the people in Northern Punjab or Western U. P. where people are chiefly wheat eaters. On the right bank of the river Indus in Sind and in the Distt. Hyderabad (Sind) the chief crop is rice and yet the incidence of stone is very high being highest in the world in the Hyderabad distt. of Sind. In the Distt. Nasik of Bombay Presidency the chief cereal is millet and yet the incidence of stone is fairly high being nearly as much as in Southern Punjab.

It is almost a rule that farmers eat what they grow. The cereal map of India shows no resemblance to the map of stone incidence in India. In the same way the cereal map of China also shows no resemblance to the urinary stone map of that country.

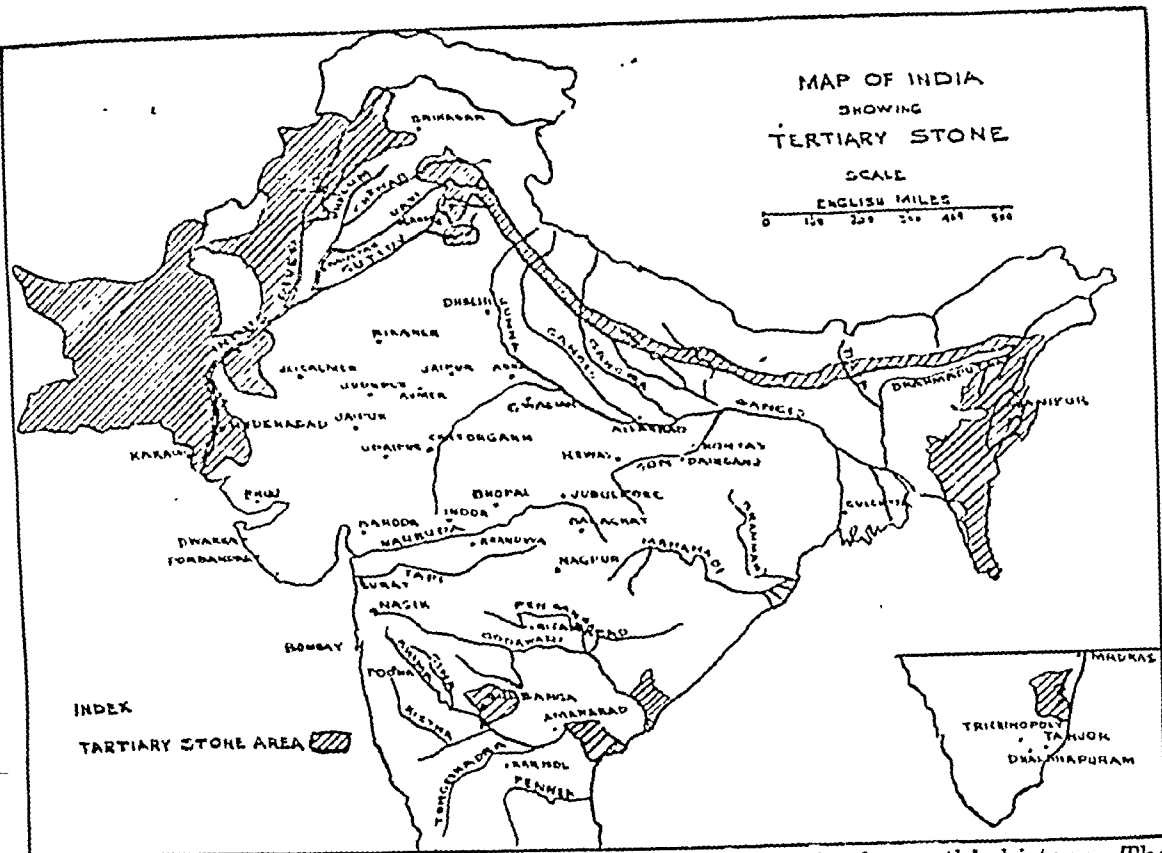
Robert McCarrison showed on Albino rats that the millet of Northern India is more stone producing than the millet of Southern India. This variation in the stone producing potency of a single type of cereal must be depending on the soil of the region and its chemical composition.

In Johannesburg (South Africa) the native population do not suffer from urinary stones whereas in the white population, the tendency is tolerably frequent. V. Vermootan is of the opinion that this is explained by the fact that the native South African lives on a simple, staple, stable and uniform diet rich in Vit. A, and having an acid ash basis and very low calcium content. The uneducated, badly housed, ill-fed, ill-treated South African native would not appreciate the above explanation as it is highly improbable that his poor diet could possess all the above merits. Poor people eat what they grow and the reason for the South African native not getting stones must be sought for in the soil and the earth of the region.

Soil is generally residual and is derived to a great extent from the rocks or the







geology of the area. Along the big rivers as in the Indo-Gangetic plain the soil is typical drift soil, transported by the river from the mountains.

### GEOLOGICAL ASPECTS.

A survey of the geological map of the world shows that the distribution of the tertiary rocks is comparable to the map of the frequency of urinary calculi in the world. There are, however, places where even with big areas of tertiary rocks (e.g. Urals in Russia) the incidence of urinary stone is not noticeable. Till recent times the Urals were not much populated and no information about the present stone incidence of the area is available. It is the combination of big river and tertiary area that goes to produce the increased incidence of urinary stones. A detailed study of the tertiary rock maps of India and China shows the same fact more vividly.

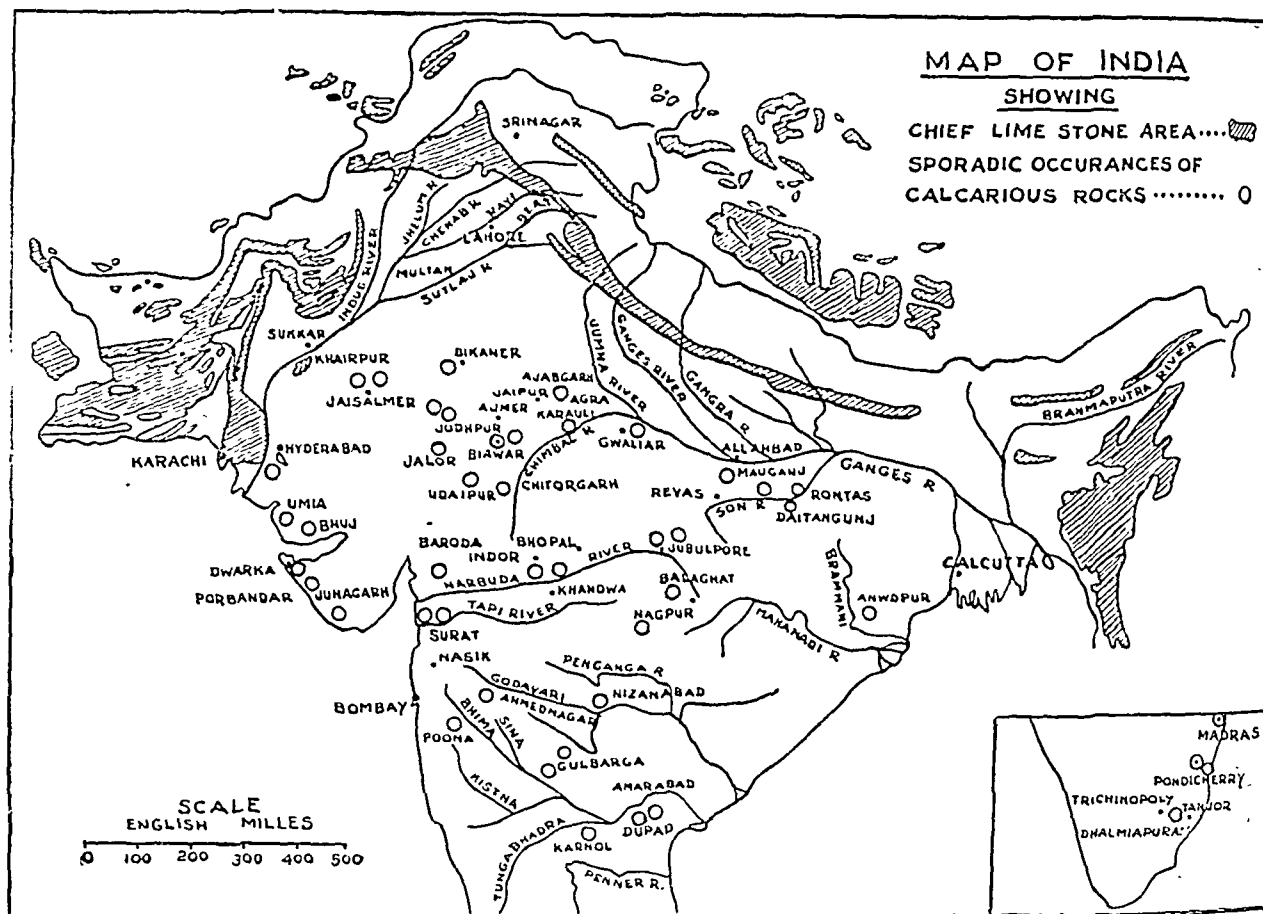
### TERTIARY ROCK AREAS.

The term tertiary rocks denotes rocks formed under water in the third stage or

period of time in the earth's history. The term does not give a definite idea of the chemical composition of the rocks but one thing is certain and that is that the tertiary rocks are usually rich in Calcium.

### AREAS OF INDIA CONTAINING CALCIUM.

The tertiaries are sedimentary rocks usually rich in Calcium. Some volcanic or igneous rocks also contain deposits of Calcium but they are not denoted in the map of Calcium distribution of India. Hence the areas not shown as "Calcareous" are not necessarily devoid of calcium. The map does not indicate the variety of the calcareous rock. The solubility of the deposit is a variable factor. A big calcareous deposit may consist of hard limestone dissolving with great difficulty, whereas small patches of Kankar may contaminate the water to a great extent as is evidenced by wells in Jhimpir in Sind. Therefore so long as the solubility of the different deposits is not studied it is useless to differentiate them on the map. In the



Rajputana desert there are concentrations of calcareous patches. These are derived from the resolution and recrystallisation of the calcium containing small, but innumerable, shells which are blown from the sea along with the desert sand. These patches at times are sufficiently calcareous to give effervescence with dilute Hydrochloric acid. Recent coastal deposits, also contain what is known as Littoral Limestone. These deposits though too small to be shown on any Geological map are nevertheless significant for the present investigation.

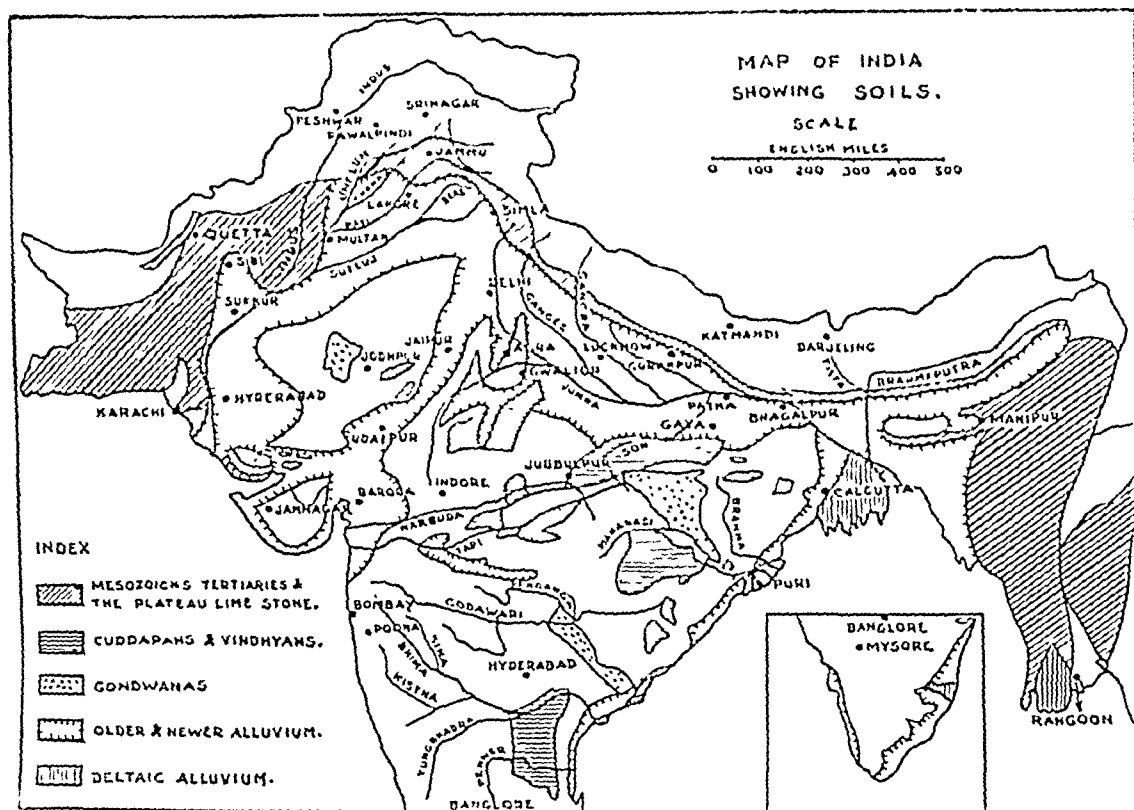
The most outstanding Calcareous areas however are those from the tertiary rocks. They are extensive in Sind, Baluchistan, North West Frontier Province, North West and North East districts of the Punjab, North West part of U. P., Manipur and an area extending South to Chittagong in Assam. The tract described is a continuous one from west to east connected by a tertiary calcareous fringe along the Southern borders of the Himalyas.

In a study of the incidence of Urinary stone, figures from the big cities are misleading. Due to the facilities of big hospitals, cases from all over the province tend to come to these centres and thus lead to apparent increase in the incidence of urinary stones in cities.

In such an extensive area of India as that which includes the Eastern United Province, Bihar, Orissa, Bengal and Assam it is only the Manipur, Chittagong, area which has any urinary stone incidence where it is in the range of 10 to 25 per 1,00,000 of the population. Other populated districts show hardly any stone incidence. There are hills in Assam rich in Calcium with hardly any population and as such without any urinary stone incidence.

Comparing the two maps of India, one of urinary stone incidence and the other of calcium distribution, certain outstanding features become noticeable. Dera Gazi Khan on the right bank of the river Indus is rich in Calcium. Distt. Muzafargarh





facing Dera Gazi Khan on the opposite bank of the river is a calcium poor area. The difference in the incidence of urinary stone in these two districts is great. Calcium rich Dera Gazi Khan has an incidence of 76 per 1,00,000 of the population while the calcium poor district of Muzafargarh has an incidence of 45 per 1,00,000 of the population. To the South of the Dera Gazi Khan district of the Punjab comes the upper Sind Frontier District of Sind with Jacobabad as its district centre. This district is poor in calcium and its calculus incidence figure is less than half that of Dera Gazi Khan. On the West of Dera Gazi Khan is Distt. Sibi of Baluchistan. Distt. Sibi in the soil map of India is non-calcareous. There is no big river flowing through it and therefore the stone incidence is lower.

In the South, districts containing Calcium deposits also happen to be the districts showing more urinary stone incidence, e.g. Nasik, Gulbarga (Hyderabad State).

A map of urinary stone incidence drawn by McCarrison closely resembles the one of calcium distribution.

Even in known calcareous areas the incidence of urinary stone is variable. As full details regarding the solubility and chemistry of the rocks are not available, these variations are expected.

In England, Norfolk is in the tertiary area rich in Calcium and has always shown high incidence of urinary stones. Calcareous areas of Westmoreland and Derbyshire also show definite incidence of urinary stones.

With the above reasoning, the immunity of the Johannesburg native from urinary stones can be well-understood as South Africa has no tertiaries and is probably poor in Calcium.

The above facts show that in a given area the regions which are calcareous and which have large rivers are the ones which show more stone incidence than the surrounding parts.

## CARRIAGE OF STONE PRODUCING ELEMENTS.

The urinary stone incidence map along the banks of the great rivers Indus and Ganges is suggestive of the fact that water carries the stone producing factor of calcium. The Ganges and the Jumna in their upper reaches, during their course in the western United Provinces, run through rich calcareous tertiary areas. As these rivers Ganges and Jumna go eastwards, they pass through non-calcareous regions. Some of the tributaries of the Jumna-Ganges system pass through the older rocks of the Peninsular block and carry little calcium into the valley. It is seen that the incidence of urinary stone between the Ganges and Jumna rivers falls as the rivers travel east. It is probable that in the non-calcareous area the river is slowly depleted of its calcium or the urinary calculus producing factor. In the south of the United Provinces some districts show high figures of urinary stone incidence due to local calcareous pockets as seen in the soil map of India.

The river Indus has rich calcareous tertiary rocks on its right bank all through its course from the source to the mouth. The incidence of urinary stone on the right bank of the river has varied according to the quantity and quality of the calcareous rocks. Regions on the left bank of the river Indus are not so calcareous as those on the right bank. Along the left bank of the river the incidence of urinary stone increases as the river goes southwards. Thus, Northern Punjab has less urinary stone incidence than Southern Punjab; Southern Punjab has less than Northern Sind (Sukkur) and Northern Sind (Sukkur) has less than Southern Sind, Hyderabad. Probably as the Indus river is continuously supplied with calcium from its right bank, the river becomes richer in Calcium, or stone producing factor, towards its mouth.

As the mighty river plays such an important role in the production of urinary calculi, the effects of the Sukkur Barrage on the incidence of urinary calculi are worth studying.

## EFFECTS OF THE SUKKUR BARRAGE ON THE INCIDENCE OF URINARY CALCULI

Figures of cases from Civil Hospital, Hyderabad (Sind) were available and are quoted below :—

1925	..	564	Annual average incidence 482.
1926	..	507	
1927	..	511	
1928	..	472	
1929	..	450	
1930	..	445	
1931	..	473	
1932	..	440	
*1933	..	492	*Sukkur barrage starts functioning
1934	..	577	
1935	..	553	
1936	..	856	Annual average incidence 653.
1937	..	733	
1938	..	709	
1939	..	709	
1940	..	1112	Average 745.
1941	..	589	
1942	..	537	

The latest census report shows an increase of the population by 14%. Even allowing 5 or 6% extra increase for local factors such as a good or a bad surgeon coming to the district, the average number of stone cases treated annually should not have grown beyond 600. One thing is certain that, inspite of the extra water made available due to the Barrage, the incidence of Urinary stones shows no tendency to fall. The words 'probable rise' are avoided deliberately as all sorts of explanations such as better knowledge, increased medical facilities, better transport, etc., could be advanced to explain the rise in the stone incidence of the district.

## WATER ANALYSIS.

An analysis of the water of the various regions is the crux of the whole problem. Figures of water analysis are quite confusing and as such figures of hardness alone are given below. Of the sulphates and carbonates of calcium in water sulphates are less likely to be absorbed in the alimentary canal than the carbonates. The Bicarbonates give water its temporary hardness and are more important in causing urinary stones.

Region.	Temporary hardness of water.	Incidence of stone per 1,00,000 of the population
Trichinopoly	0	0
Coimbatore	0.5	10 to 25
Moradabad	12.0	
Lucknow	9.0	
Delhi	6.0	
Poona	7.0	
Karachi	12.0	25 to 50
Jacobabad	20.0	
Larkana	10.0	
Shikarpur	14.0	75 to 100

The above figures are not very convincing as the proportion of the incidence of urinary stone and that of temporary hardness of water is not mathematical. Figures of water analysis of a particular province are far more convincing.

#### WATER ANALYSIS IN TOWNS OF THE UNITED PROVINCES

Town.	Temporary Hardness	Incidence of stone in the area
Cawnpore ..	4.	3.
Meerut ..	4.	8.
Allahabad ..	6.	4.
Benares ..	7.	13.
Agra ..	7.	14.8
Lucknow ..	11.	15.5
Aligarh ..	13.	15.0
Moradabad ..	13.	21.0

Thus the incidence of urinary stone is higher where the temporary hardness of water is greater.

In Bihar the same thing is observed.

Town	Temporary Hardness	Stone incidence
Muzzaffarpur.	20.0	3.
Bhagalpur ..	7.5	5.
Gaya ..	6.6	6.
Patna ..	14.0	13.

It appears to be a foregone conclusion that temporary hardness of water is a definite cause of urinary stones.

Hamilton Bailly states "Old beliefs die hard and it will be a surprise to many to learn that urinary calculi have little or no connection with hard water and excessive perspiration."

With the evidence produced above such a statement must be considered wrong.

In the present work some studies were made regarding the acid radicals taking part in the formation of urinary stone.

The percentage of uric acid in urine at various ages is different as given below :

Age in days	% of uric acid in urine
1 .. ..	0.18%
2 .. ..	0.24%
4 .. ..	1.5% (Baby died of Jaundice)
5 .. ..	0.4%
6 .. ..	0.37%
7 .. ..	0.21%
9 .. ..	0.42%

Age in years	% of uric acid in urine
1½ ..	0.153%
2 ..	0.152%
3 ..	0.142%
8 ..	0.097%
9 ..	0.095%

Age Group	% of the uric acid in urine.
15 to 20	.. 0.08%
20 to 25	.. 0.075%
25 to 30	.. 0.060%
30 to 35	.. 0.060%
35 to 40	.. 0.062%
40 to 60	.. 0.075%

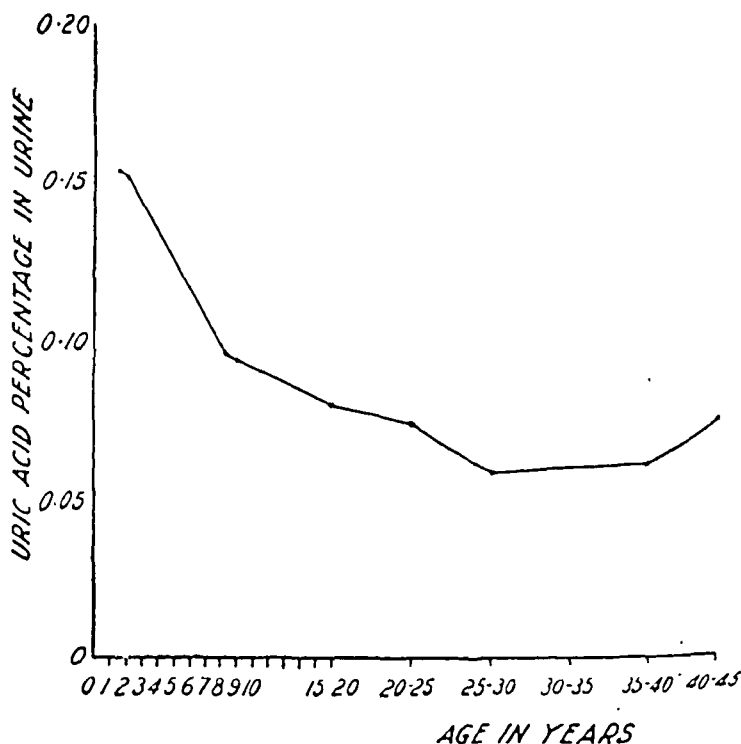
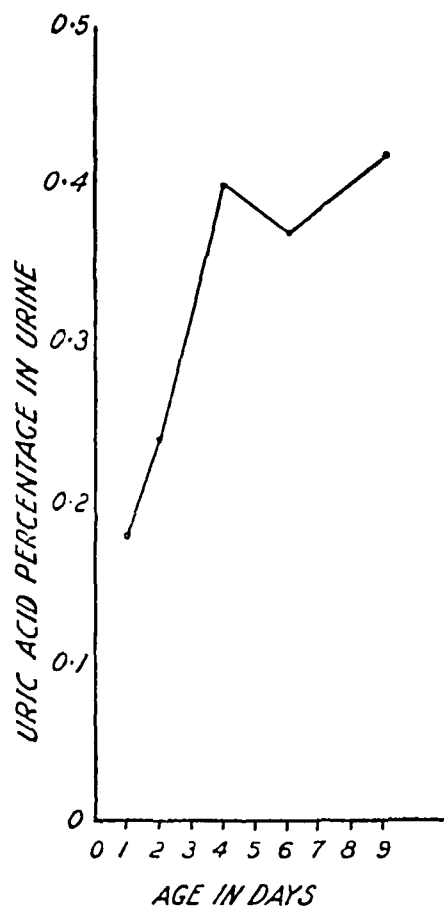
It is observed that the urinary uric acid is very high in infancy, rapidly falls during childhood, remains almost steady in adult age and tends to increase again in old age.

The figures for urinary uric acid percentage would suggest that uric acid and urate stones must be more common in children and it is so, as far as naked eye classification goes.

#### OXALIC ACID

Calcium oxalate in solution is precipitated immediately if the solution is made alkaline by any base, weak or strong, showing that in cases of oxaluria, the urine must be kept acid in order to prevent the formation of urinary stone.

It is stated in almost all text books that the crystals of oxalate, as seen under a microscope, are envelope-shaped or sometimes dumb-bell shaped. However, on a study of the various crystals of oxalates it was found that it is extremely difficult to have a crystal of Calcium Oxalate. The Calcium Oxalate looks more like amorphous particles. It is the Potassium oxalate crystal which is envelope-shaped and the crystals usually seen in the urine of an

GRAPH SHOWING PERCENTAGE  
OF URIC ACID WITH AGE

oxaluria patient, are always of Potassium never of Calcium.

### PHOSPHORIC ACID

Phosphaturia is usually evidenced by white urine. The white colour of the urine does not however mean that the urinary phosphates are increased quantitatively. It is often only the ammoniacal decomposition or the alkaline reaction of urine that gives the white colour to the urine. Even with white colour urinary phosphates may be normal or subnormal.

Vegetables, milk diet, alkaline mixture and excessive carbohydrates increase the urinary phosphates. An experiment on a student gave the following results:

	% of phosphate in the urine.
Normal diet (Vegetarian) ..	0.063%
Vegetables, milk, 2 chapaties and Bicarbonate of soda mixture.	
1st day ..	0.090%
2nd day ..	0.150%
3rd day ..	0.360%

The experimental food became nauseating and on the 4th day the Soda Bi Carb mixture was dropped.....0.15%.

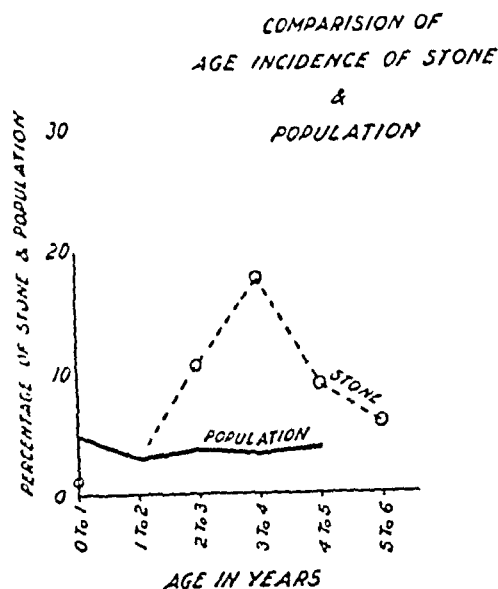
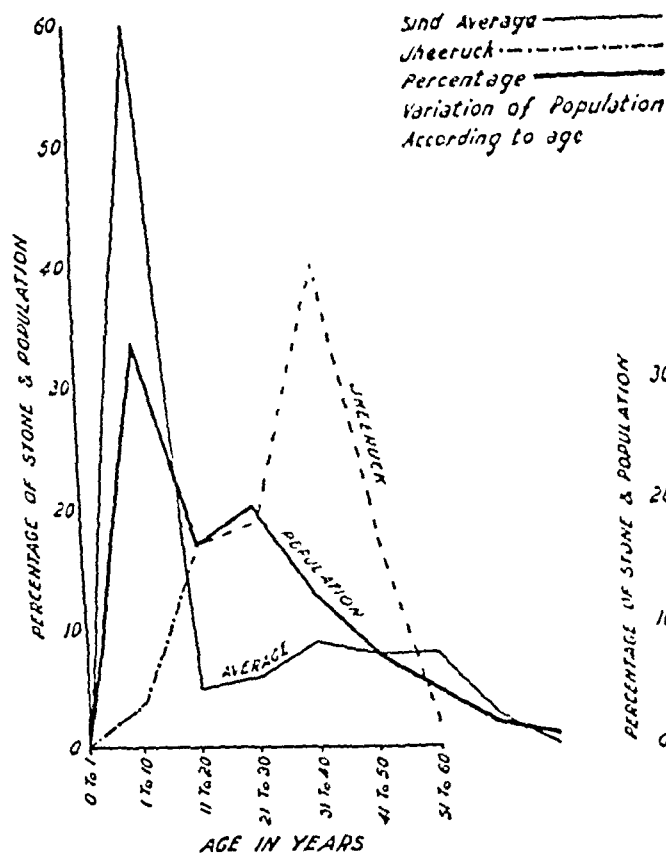
Basing the facts on the results of the experiment, it was surmised that it was the Bicarbonate of soda that was doing the greatest mischief. Alkalies and acids are relative terms and if Bi-carbonate of soda increases the urinary phosphates then deficiency or absence of hydrochloric acid in the stomach would do the same.

Fractional test meals done on a few cases of Phosphaturia showed that in all these, gastric hydrochloric acid was either deficient or absent. It is suggested that in all cases of Phosphaturia one should do gastric analysis and then treat them with acid hydrochlor. dil., if required, in preference to acid sodium phosphate.

Besides the commonly discussed salts of calcium, calcium sulphate is a fairly usual finding in the composition of urinary stones (Barium chloride test).

### AGE INCIDENCE

In India and China urinary stone is a disease seen mostly in children, and it



used to be the same in Europe a hundred years ago. Now, in Europe and in England, stone is not common in children. In India and China the general standard of health is poor and more so of children whose rate of mortality is very high. It is probable that the fall in the urinary stones among children in Europe is due to better conditions of health.

A study of the age incidence in districts of Sind showed that the percentage incidence of stone at each age period varies to a certain extent from district to district.

Age group.	Variation in % of stone incidence.	Average % of stone incidence.
Less than 1 year	0 to 3.5	1.1
1 to 10	42.8 to 67.0	59.0
10 to 20	1.5 to 6.	4.5
20 to 30	5.0 to 13.5	5.9
30 to 40	6.5 to 14.6	8.9
40 to 50	4.5 to 13.4	7.8
50 to 60	4.5 to 12.2	8.0
60 to 70	1.5 to 3.2	2.3
70 to 80	0.4 to 1.0	0.3
(Total No. of cases 1852)		

It is in the district of Larkana (Sind) that we get the higher figures in the older age groups.

Even in Sind itself figures from cases in Jheeruck dispensary are surprisingly different as can be seen from the following table :

Age Group.	% of stone case.
Below 1	0.
1 to 10	4.5
10 to 20	17.2
20 to 30	20.0
30 to 40	40.0
40 to 50	19.0
50 to 60	2.7
(Total No. of cases 115)	

Jheeruck is one of the health resorts in Sind and a tuberculosis sanatorium is located in the town.

#### INCIDENCE IN TOWNS AND VILLAGES

People in towns are said to get less urinary stones than those in the villages.

The following figures in this respect are interesting :—

District town.	% of the district population living in the town.	% of cases of stone coming from the town.
Hyderabad	17.6	8.3
Karachi	54.2	24.2
Larkana	5.4	8.7
Nawabshah	2.9	20.9
Jacobabad	6.7	20.8

It would be noticed that except in Karachi and Hyderabad the stone incidence is actually higher in the towns than in the rural population.

One of the possible causes of a lower stone incidence in the Karachi and Hyderabad city population may be the filtration and chlorination of water in these cities. Other towns in Sind have no such facility.

#### MISCELLANEOUS

There are certain other facts regarding urinary stones which may be of importance. Whales in their natural state do not suffer from urinary stones as far as can be ascertained from scientific observers among whalers.

In the olden days it is said that sailors who used to eat mostly salted food were immune from urinary stones. The present day sailor has living conditions as if he is on a moving modern city. In the Jail records of Sind cases of urinary stone are almost unknown. The very few detected are among the new comers.

#### SUMMARY AND CONCLUSIONS

1. The uriniferous tubule probably acts on the principle of a flush.

2. All deposits in the kidney which are insoluble, pigments and casts could be seeds of urinary stones.
3. Sodium, chlorides and sulphates, have the property of preventing the formation of urinary stones.
4. The Tertiary rock map of the world in association with the big rivers resembles the map of distribution of urinary stones.
5. Scarcity or abundance of water has no effect on the incidence of urinary stones.
6. Temporary hardness of water is one of the most important causes of urinary stones.
7. The envelope-shaped crystals seen in oxaluria are of Potassium oxalate and not of calcium oxalate.
8. In cases of Phosphaturia, gastric analysis often shows achlorhydria or hypochlorhydria.
9. Calcium sulphate is a fairly common constituent of urinary stones.
10. Age incidence of urinary stones probably depends on the general standard of health and care of children.
11. Town people get more urinary stones (than the rural population) if the water is not chlorinated or filtered.
12. Whales, sailors of old days and long term jail inmates have no urinary stones.

I am grateful to Lt.-Col. Grey, Lt.-Col. Eminson, Dr. Aklani and Prof. Pithawalla for giving me every facility in collecting information.

## MALUNITED FRACTURES AND DISLOCATIONS\*

by T. H. SOMERVILL, F.R.C.S., *Neyyoor, Travancore.*

Fractures as described in text books are nearly always assumed to be recent, and the treatment for these is so adequately described in them, and probably so well known by most surgeons, that it would be an impertinence for me to repeat now what most operating surgeons already know so well.

But, as we all know, fractures as we meet with them in India, more especially in country districts, are not often brought to a surgeon or to a hospital at once, but are only too often submitted to our treatment weeks or months or even years later, having been first treated by local quacks, or neglected and allowed to unite in bad positions, or to show non-union, with stiff joints and other disastrous consequences, such as traumatic ossification, Volkmann's contracture, etc.

During the last 22 years, while at work in a large surgical centre in the extreme South of India, I have felt again and again the need for guidance in the treatment of such cases. The text books, even where they are right, can only remind us of general principles, and are of little or no value in the specific treatment of any particular case. In many ways, therefore, we have to feel our way through the treatment of a case, doing as best we can by the light of general principles and of such knowledge as we have gained from similar cases in the past. It is my hope that my own experience—often that of failure—in these cases may be of some value as guidance in the treatment of late and maltreated fractures and dislocations.

My only justification for writing this article is that I was working for 3 years (from 1918-21) under Sir R. Jones in Liverpool and Leeds, doing little else, but the correction of malunited bones and stiff joints, after which I came to India, and I have thus had a continued experience of this class of case extending over 25 years. Obviously in a short space a

complete account of this large subject cannot be given, but rather a series of hints as to what to do, and what to aim at, expressed largely in the form of notes for brevity's sake.

First we must remember *the general principles* of the treatment of fractures:

### A. ESSENTIAL:

1. Immobilisation, as absolute as the surgeon can make it by plaster or appliances, of the fractured ends. This must be continued until the fracture firmly unites, and not relaxed one day before this occurs. It must be combined with:
2. Free active (not passive) movement of all other joints from the earliest possible time, best of all from the day after the fracture (or, in late cases, the re-fracture, bone-graft, osteotomy, etc.)

### B. WHEN POSSIBLE:

3. Good apposition of fractured surfaces.
4. Good alignment of the two or more fragments of the bone or bones.

### C. WARNING:

5. Passive movement is almost always wrong, as is early massage except in some cases of nerve-involvement.

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*Note*—Some fractures heal well with free active movement even of the joints on either side of the fracture from the very beginning, e.g. A fracture of the upper end of the humerus, if resting on an abduction ("aeroplane") splint, properly applied, can be allowed to attempt movements of shoulder and elbow from the very first day. If he is prepared to undergo some pain, and the movements are always active and never passive, and if he is under the observation of the surgeon throughout the first two months, this treatment though theoretically unsound is very successful in producing ultimately a

\* A paper read at meetings of the Delhi Medical Association on Oct. 6, and of the Travancore Medical Association, Nov. 4, 1944.

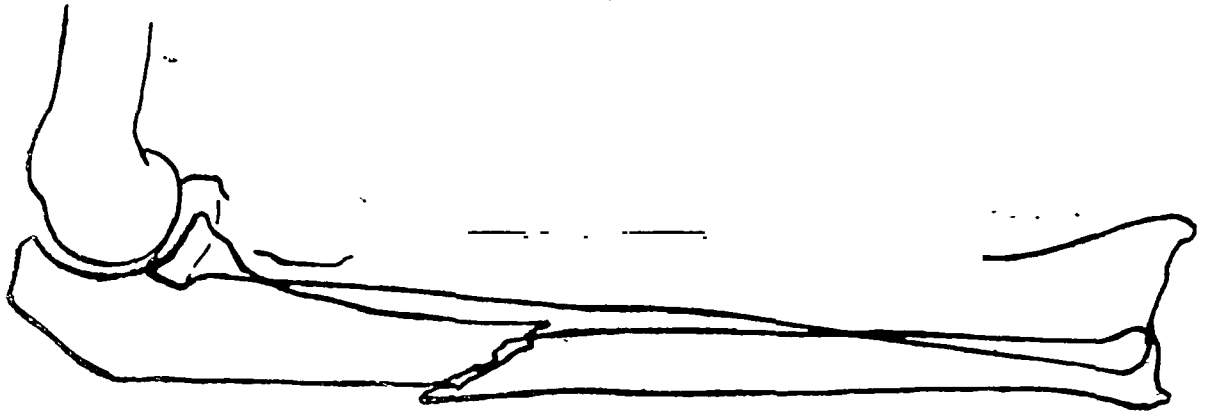
perfect functional result. Some cases of Pott's fracture show similar reaction to free movement from the very first. All "half-way houses" between this treatment by mobility and strict immobilisation are nearly always thoroughly unsatisfactory.

(1) *Malunion, firmly united, of one bone.*

*Shortening*: Does not matter in hume-

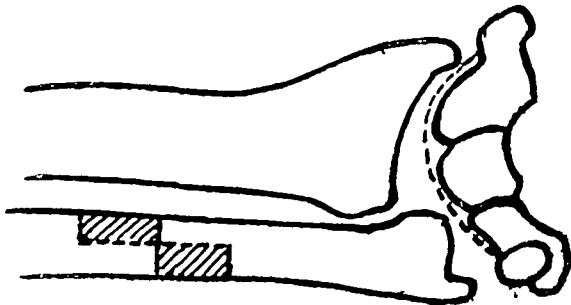
bone of the wrist joint, therefore shortening of it makes a bad wrist. If an ulna is shortened, and the elbow is stiff and painful, we have to think of excising the head of the radius, a simpler operation than lengthening the ulna, for lengthening of any bone is very difficult owing to the concomitant shortening of muscles, and the difficulty of excising scar tissue around

Fig. 1.

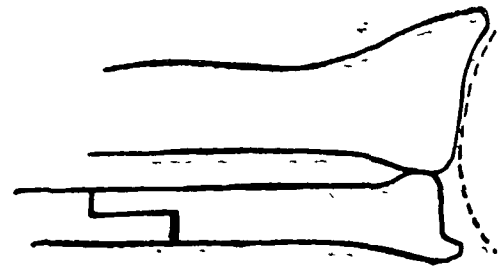


Shortening of ulna. Radius pressed up against capitellum. Painful elbow.  
Treatment—excise head of radius,

Fig. 2.



I.



II.

Shortening of radius. Wrist radially deviated. Awkward hand movements.  
Treatment—excise a piece from ulna as marked (I). Join together as II.

rus or femur up to 2 inches. Does matter in radius or ulna, not so much if both are involved. The ulna is the bone of the elbow joint, therefore shortening of it makes a bad elbow. The radius is the

the fracture, either of which may prevent the lengthening we should like to make. (Fig. 1).

Similarly if a radius is shortened, the ulna will project beyond it at the wrist, causing radial deviation of the wrist; a very crippling disability, for all wrists, if deviated at all, are stronger if deviated towards the ulnar side.



III.

Alternative treatment of ulna, useful if inferior radio-ulnar joint is ankylosed.

For these cases, excision of a piece of the ulna 1 or 2 inches above the wrist joint is the treatment of choice, the mortice-like ends being tied together with



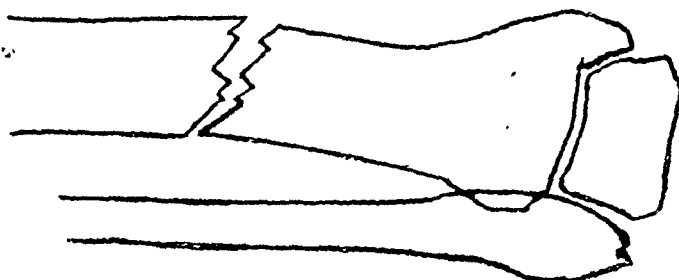
strong catgut or linen thread. Immobilisation must be complete, until the fracture is firmly united. (Fig. 2.).

In the tibia, shortening seldom takes place unless the fibula is also fractured; if it is, very great disability may result. But here the disability is usually one of *direction* rather than *length*. The tibia and fibula must be cut, and fixed in plaster with the foot in as nearly as possible the natural position, paying all regard to the *direction* of the bones, but not attempting any lengthening of them, and not necessarily getting the *alignment* perfect as long as perfect *direction* is maintained. (Fig. 3.).

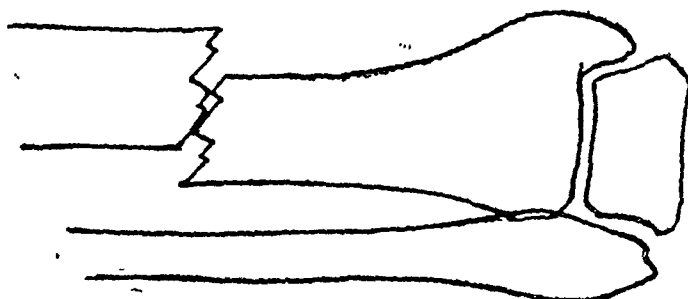
If there is great disability, look out for widening of ankle joint and undetected fracture of fibula. Correct this, and if it seems to be indicated refracture os calcis, and put Steinmann's pin in distal fragment with  $1/6$  or more of body-weight as extension. When callus formation is satisfactorily started, put in plaster including pin, foot in slight dorsiflexion, for at least 4 weeks. If dorsiflexion impossible, put in slight equinus position. X-rays important at all stages. Must be immobilised until it is healed. Weight-bearing allowed one month later.\*

(2) *Malunion of Direction or Alignment.*  
Mild degrees do not matter except

Fig. 3.



Bad position for tibia. Union is end to end but direction of lower fragment is wrong.



Better position. Direction is preserved. Foot will be in orthopaedically sound position

*Os Calcis.* Very often this is best left *uncorrected* if no great disability in walking is shown. Bone projecting near the external malleolus must be removed with a chisel enough to free the malleolus from contact with it during movements:

(a) *Radius and ulna.* Tendency to cross union. If shortening is not excessive, usually it is better to operate on one

\* In the discussion following this paper, there was a general opinion that os calcis is usually better left alone, if united, even in bad position.

bone—the worst—only, chiselling the ends to suitable shape—in fact doing a modified cuneiform osteotomy—and putting up in Plaster, usually best in full supination. Elbow to be included if upper ulna is involved, Wrist to be included if lower radius is the bone to be corrected by operation. All joints of fingers must be kept mobile.

(b) *Tibia and fibula.* By whatever means possible, the direction *must* be corrected, or walking will be painful.

(c) Upper and lower ends of femur. *Plating* is usually the best operation, as the forces concerned are so strong as to threaten breaking any graft except perhaps a whole-fibula graft. As soon as union is firm, the plate should be removed.

### (3) MALUNION OF ROTATION.

(a) *Radius or ulna.* Although the radius is the bone of rotation and the ulna merely the axis around which it rotates, if a fracture has been set so that rotation is limited or painful, *either bone* may be at fault, ulna just as often as radius. If there is difficulty to pronate, it is probably due to the fracture having been set in full supination. The ulna is more accessible, and the operation on it less disturbing to muscles etc., so it is usually the bone to be operated if it has been fractured either alone or with the radius, and the hand must be held in full pronation by an assistant while the ends of the bone are levelled and wired. Splint for a few days, then plaster in full pronation. The wire should be taken out, a window being cut in the plaster for this purpose, about 2 weeks later, and the plaster left on till union is firm. Typists must be able to pronate, others prefer ability to supinate for eating purposes. If there is difficulty to supinate, the operation must be finished on the bone, and the hand put up in plaster, in full supination.

(b) *Neck of femur.* May be ununited or malunited. If ununited, Smith Peterson pin. (Methods in text books). If malunited, open operation, osteotomy, and either Steinmann or Peterson pin, better the latter. *But* remember, the latter is a serious operation with its own risks of

stiffness or other disability afterwards and should only be done if disability of rotation is really crippling—not merely to correct a slight inconvenience. Wherever possible osteotomy if required should be trochanteric. If the head of the femur is absorbed or fragmented, Whitman's or MacMurrays, or some similar operation (see textbooks) may have to be done.

(c) *Humerus.* Some degree of torsion of the humerus is tolerable to the patient but I have seen two cases in which there was inability to rotate the humerus sufficiently to use the elbow properly, an osteotomy, with support of the arm on an aeroplane splint, had to be done. The elbow must be moved every day to the fullest possible extent, while the arm rests on the splint. This splint, or plaster with arm abducted and elbow bent, will keep the humerus in the mid-rotated position.

(d) *Old compound fractures with sequestra.* If there is no great orthopaedic disability, these must be treated by radical removal of all sequestra, the spaces left being filled with muscle grafts. These grafts must be sewn into position (best by a silk-worm gut stitch through the end of the graft tied on the skin opposite—beware of penetrating arteries or nerves, especially in the leg), for it will be necessary to keep up the movement of joints, and this is apt to pull the graft out of the hole which it fills. If a simple orthopaedic operation is required, such a correction of the alignment of the long bone, this may be done before the sequestrectomy wound has been healed for any length of time, unlike bonegrafts or operations involving introduction of plates or wires, which must not be done until 6 months after healing. If sepsis is *not* as serious a consideration as time, the orthopaedic operation may be performed earlier\* (of course unless a bonegraft be involved). In this type of case, free use of Sulphathiazol powder mixed with Proflavine, at the time of operation, is advisable. Immobilisation heals the sepsis as well as uniting the fracture.

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\* I have done several of these cases successfully, while the sequestrectomy wound was still discharging pus, but when only one infecting organism could be found.

(c) *Non-union of bone.* This is nearly always due to failure to immobilise the fracture. Even in cases up to six months old, a good plaster with real immobilisation may effect union, for the hyperaemia of the bones which causes decalcification is no longer stimulated by movements; ischaemia and sclerosis is soon produced, and the fracture will have the chance, which it has never had before, of uniting. Immobilisation depends on the prevention of all movements of the two fragments on one another. Plaster if used, must adequately prevent such movements as the following:—

(1) *Radius and ulna.* Pronation and supination in the forearm may occur and cause non-union if the plaster be not carried above the elbow, and made to include the wrist (but not the fingers).

(2) *Humerus.* Rotation will occur if the plaster does not include the shoulder joint in some form of spica; the plaster should extend to the wrist-joint.

(3) *Carpal Scaphoid.* Plaster must encase the wrist on both sides as well as above and below, to stop all flexion, extension, adduction and abduction of the wrist—these latter movements hinder

union of the scaphoid. Fingers must be free to move.

(4) *Neck of femur.* Plaster cannot prevent some movement of the loose femoral head; only a Peterson Pin can do that. Alternatively, conversion of an adduction of the femur to abduction by a trans-trochanteric osteotomy will produce a tendency to impact, and therefore to remain relatively immobile and unite. (Fig. 4).

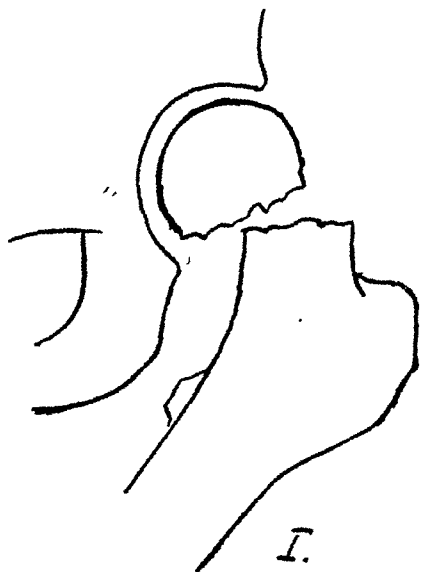
(5) *Femur (shaft).* Usually requires a plate or graft, as it is difficult to immobilise by other methods. Plates *always* get loose in a few weeks, before union is firm; hence external splinting or plaster is imperative until radiography shows that the bone has actually healed.

(6) *Tibia.* Must not be allowed to rotate; plaster must include foot up to roots of toes, and knee must be bent, plaster going well above it to the groin.

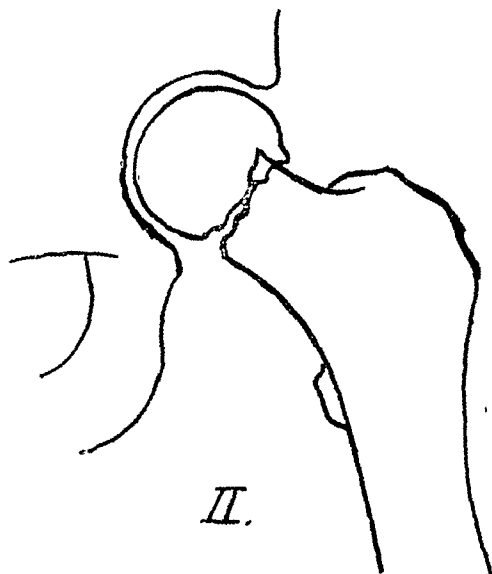
(7) *Non-union in the upper fibula,* the upper radius, or the lower ulna may be of no great importance and lead to little or no disability.

If the bones have not got sclerosed ends, union is always theoretically obtainable.

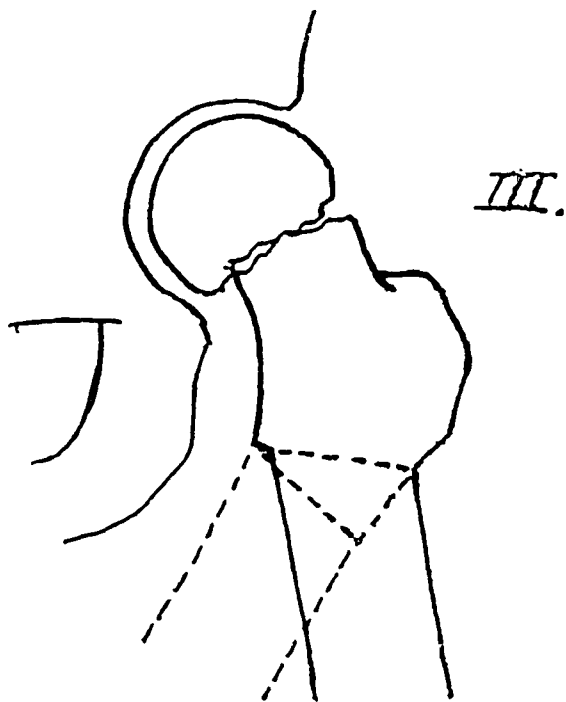
Fig. 4.



Adduction fracture (unstable).



Abduction fracture (stable).



Adduction fracture converted to stable abduction position by cuneiform osteotomy.

If the ends are sclerosed in ununited fractures, union can *never* take place, and drilling of the bone-ends with multiple holes, or better a bone grafting operation, is indicated.

Points to be noted in bone grafting are mainly the following :—

- (1) The graft must be large enough to be strong, and the cut-away of bone must be large enough to open up cellular spaces and marrow.
- (2) The graft must fit tightly into both bones so as to allow no movement.
- (3) It must be rectangular, an inlaid graft being nearly always the best. Pegs in medulla are to be avoided when possible as they block the active living marrow from access to the area for repair.
- (4) Grafting must never be done until a septic fracture has been firmly healed for at least 6 months.
- (5) No foreign bodies such as wires should be introduced, if they can be avoided, to fix the graft in position.
- (6) Plaster of Paris must be unpadded and keep the bone immobile while

allowing all joint movement that is possible consistent with absolute immobility of the bone.

- (7) The graft must in my opinion be autogenous, other bones such as ivory pegs, beef bone etc., being always inferior. It should be taken and put in at one sitting.

*Involvement of a joint.* We now approach the most difficult cases, those of uncorrected dislocations, and fractures involving joints which have become stiff, or painful, or ankylosed. These cases present many problems so difficult that we must all confess to having had many failures among them. Each one is different and has to be studied as an entity; but there are certain general lines along which we must go in the treatment of all.

(A) *Maltreated and unreduced dislocations without fracture.*

*Shoulder.* This is nearly always anteriorly dislocated, and operation is best done through an incision along the posterior border of the anterior axillary fold. The vessels and nerves are defined, and gently held out of the way.

There will be much scar tissue, which should be removed. The capsule will probably be unidentifiable except in a recent case (under 1 month). The field of injury must be cleared until the humerus can be easily put into its proper position in the glenoid cavity. The clavicular origin of the deltoid may have to be detached. There are two alternatives then, one of which must be done; if not, the dislocation will certainly recur, unless the shoulder is so stiff as to permit no movement worth speaking of :—

(1) A posterior incision along the posterior border of the deltoid must then be made, and  $\frac{1}{4}$  to  $\frac{1}{3}$  of the deltoid removed from its insertion; this is passed through the quadrilateral space and sewn tightly with linen thread to the acromion process. After one week or less, movement of the joint must be started, almost entirely active not passive.

(2) *Alternatively,* Nicola's operation should be done; this operation consists in the cutting of the tendon of the long head

of the biceps and its fixation through a tunnel made with a  $\frac{1}{4}$ " drill through the outer part of the head of the humerus. This avoids a second incision. For method see textbooks.

**Elbow.** Here we have a very difficult type of case. An elbow dislocated for more than 3 weeks cannot be said to be a satisfactory case. It cannot be reduced by manipulation; if reduced by operation the great majority of cases become very stiff indeed in their movements, and some get completely ankylosed. There are three possible courses of treatment:—

(1) If there is a fair range of movement without pain, it is probably best to do nothing.

(2) If movement is limited or painful, some surgeons advise the forcible bending of the elbow, which nearly always fractures the olecranon. The arm is then splinted in flexion, and the olecranon either becomes a sesamoid bone in the triceps tendon, or can be removed by operation two or three weeks later. This procedure had the approval of no less an authority than Sir Robert Jones.

(3) Operative attempt to restore the joint. Preliminary excision of the head of the radius must be done through an anterior incision. The second operation is done within 3 weeks, by a posterior incision. The radial nerve must be continually borne in mind. The olecranon process must be sawn off with the attached triceps, and turned up. Scar tissue should be removed until the articular surfaces of the ulna and humerus and the olecranon fossa are exposed, and these *must not be damaged* by the operation in the course of exposure.

(A) If after doing this the bones will articulate together without tendency to dislocate, they may be left in position, and the wound closed. The after treatment is:

(1) Active movement from the first if the joint is not easily dislocated otherwise; if it is;—

(2) Firm splinting in plaster for 2 to 3 weeks from shoulder to wrist, followed by active movement. *On no account* must passive movement or massage be em-

ployed. The prognosis of this conservative operation is not good, but a few cases do very well. Most others have to have a secondary arthroplasty some months later.

(B) If the position is felt to be unsatisfactory, the only thing to do is to do an arthroplasty in the right arm, or to aim at ankylosis at 135 or 140° in the left (writers, 110°, and so on according to the profession of the patient).

**Wrist.** Dislocation of the wrist is uncommon without fracture, especially in falls from trees, or extreme violence, and if there is much pain, stiffness or ankylosis, the wrist will probably have to be fixed to the radius, every effort being made to preserve the rotation of the radius round the ulna. The wrist must be fixed by a bone graft, from radius to the os magnum and any other carpal bones that may be convenient; if possible *including the 2nd metacarpal* (better than the 3rd, as a little ulnar deviation, as well as some slight dorsiflexion of the wrist, gives the ideal position). On no account should there be radial deviation, nor palmar flexion, in the final position.

The operation for choice should be done from the *dorsal (extensor) surface* of the hand, owing to the liability of many tendons (and not just 1 or 2) to become adherent to the scar if operation is done on the flexor side. If pronation and supination cannot be obtained through ankylosis of the lower radius to the ulna, an inch from the lower quarter of the ulna may have to be removed in order to obtain the requisite mobility, which it is very desirable to preserve if the wrist itself is to be ankylosed. (Other complications are frequent but cannot be dealt with here; such are adherence of tendons, comminution of ends of bones and presence of sequestra).

**Hip.** Dislocations of long standing are usually best untreated, unless pain or disability are very great. Attempts at reposition are very unsuccessful, and apt to be followed by osteoarthritis and great pain, necessitating further ankylosis, or arthroplasty, or MacMurray's operation, or if the dislocation recurs, Lorenz's bifurcation osteotomy. Hence if treatment is called for, it is best to perform arthro-

plasty or arthrodesis as the first operation. The question of which to perform is a matter for the opinion and skill of the surgeon. In nearly all operations on the hip just the best incision is anterior J. shaped (Smith Peterson) with removal of the great trochanter and displacement upwards of the Gluteus medius muscle, the tensor fasciae being drawn forwards. Even for a backward dislocation this gives the best and most bloodless access to the joint.

**Knee.** Dislocations are very rare as a result of injury, but common due to contracture of the hamstring muscles, and to long-standing (or rather—sitting!) flexion of the knee, kept flexed by the patient because extension is painful or difficult.

The best treatment in bad cases is arthrodesis. In cases with paralysis of the quadriceps, it is the only treatment. It must be performed by sawing the ends off both femur and tibia, with a sliding bone graft to reinforce the operation, as the lower end of femur and upper end of tibia, however skilfully shaped so as to be adherent together, are notoriously difficult to persuade to unite by bone and not by fibrous union. In slighter (subluxated) cases, Steinmann pin in the tibia 3" from the upper end may be used to pull the tibia gradually into a workable position, and exercises with *active* extension instituted as soon as possible.

**Ankle.** Dislocation without fracture is uncommon, but when it occurs is usually posterior. It is nearly always accompanied by a separation of the lower ends of tibia and fibula with fracture either of fibula or of the internal malleolus. In a late case operation will certainly be required. After reduction (with excision of all scar tissue interfering with the joint itself), the tibia and fibula will probably have to be screwed together, either with an external or internal screw. A Bone screw is best, or vitallum. This must be inserted far enough from the ankle joint to avoid danger of causing arthritis. It must be taken out as soon as the fracture if any is united. If the patient can bear the pain, the fullest possible (active) movement from the first day after the operation gives the best chance of recovery.

The alternative treatment is absolute immobilisation for 6 weeks or until union occurs.

(6) *Involvement of a joint in a fracture, including fracture-dislocation.*

**Shoulder.** The details of operation on the bone vary from case to case. The important thing is that there should be no projection at the upper end of the head of the humerus. After reduction of the dislocation as already described, the arm must be put on an aeroplane splint, but not fastened to it except at night; the patient must be encouraged to move the arm off the splint if possible, even if only for 1/8 inch, and if he is able to do this in 3 weeks, the prognosis is good. Wrist, elbow, etc., must of course be moved freely from the beginning.

**Elbow.** Here are seen our most difficult and varied cases, owing to the frequency of periosteal new bone, and of traumatic ossification around the joint. Preliminary faradic treatment of the flexors and extensors of the elbow and also often of the forearm muscles, is nearly always a good thing, and is essential for several weeks in cases whose elbows have been immovable for many months or years. In addition to bony and joint injury, there is often some degree of Volkmann's contracture, which makes the case still more difficult to treat. This will be dealt with later. In the absence of actual dislocation, the chief principles to be borne in mind are :—

(1) Good Radiographs A. P. & L. are essential.

(2) The movement of the joint may be limited either by adhesions, or by a bony block; this latter, if it be *only* limiting flexion and on the flexor surface of the humerus, must be removed. This is best done by an anterior incision on the ulnar side of the bone, so that all vessels and nerves except the radial can be defined and avoided. Limitation to extension by bone or fibrous tissue in the olecranon fossa must be similarly dealt with by a posterior incision. This can be extended if necessary so that by suitable retraction either of the condyles and the whole joint can be explored. Fragments of condyles usually can be left in situ. Sometimes a

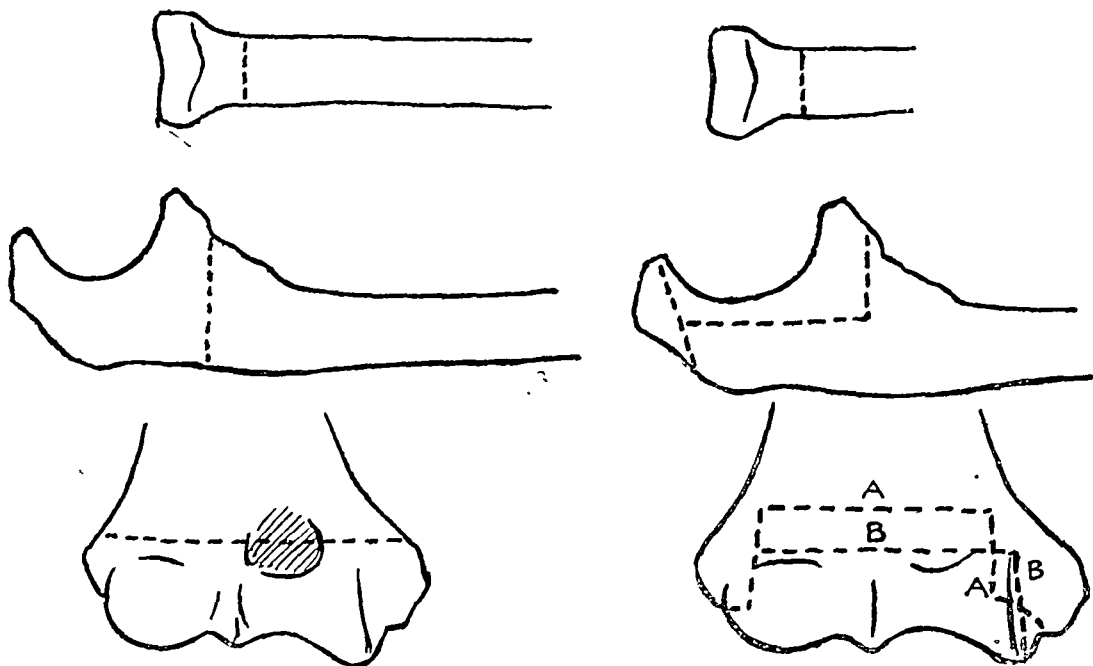
fragment of capitellum is in the joint cavity, and must be removed. If after tidying up the joint, so to speak, good movement is obtained, the limb is splinted at right angles for 2 days, and then put up in unpadded plaster at the corrected position in *semipronation*.

If good movement is still not obtained, the head of the radius must be excised before the operation wound is closed. The patient is to lie in bed with the bent arm arranged so that the humerus is vertical and an extension of the weight of the arm plus 2 lb. is put on; on the third day (i.e., when all bleeding has stopped): Immobilise for 14 to 17 days, then start active movements. The plaster being removed by cutting along radial and ulnar borders along its whole length; half the plaster is used as a splint and firmly bandaged on when the arm is at rest.

More grave damage than can be dealt with by the operation just mentioned may call for either excision (arthroplasty) of the joint, or arthrodesis, according to the patient's profession, and the relative utility of a weaker movable joint and a strong fixed one. (Fig. 5.)

Besides the textbook arthroplasty with fascia lata grafts over all the bone-ends involved, it is possible to dispense with these. The arm is subjected to no extension for 3 days, after which it is extended by 1, 2 and 3 lbs. on 3 successive days, kept at 3 or 4 lbs. for 2 weeks, then the extension is reduced to 2 lbs. for 2 days and 1 lb. for 2 days. Next day the supported arm is bent to 90° by the patient. Active movements are then started, the arm being kept in a sling bandaged to the side when not in use. This treatment is no good for an excision of elbow; bones must be cut as in ordi-

Fig. 5.



**Excision:**—Split the triceps and preserve its insertion into the fascia covering the forearm muscles.

Splint at right angles or less for 18 to 20 days, then active movements.

**Arthroplasty:**—Reflect the triceps with the olecranon, replacing this after the operation with catgut sutures.

Splint straight out for 1 or 2 weeks, then at right angles for 2 weeks or less; extension about 2 lbs. Then do active movements.

A gives greater stability to the joint;

B gives freer movement.

nary arthroplasty. The advantage of this method is—it is less likely to go septic, owing to the operation being shorter and less complicated. Disadvantage is that about one third of the cases are unsuccessful and finally ankylose.

The chief principle in this as in other arthroplasties is—*remove plenty of bone*; what is apparently too much removal is probably about right. Penicillin if obtainable is very useful as a prophylactic—mixed with Sulphathiazole powder, it is left in the joint cavity; alternatively, Sulphothiazole with 2% of proflavine and 5% Sod. Bicarb.

*Wrist.* Has already been dealt with.

*Hip.* Arthroplasty is better not done unless both hips are involved. Arthrodesis at 150° gives a useful joint but necessitates the use of a commode afterwards. (For osteotomies Lorenz's, MacMurray's, etc., see text books).

*Knee.* Aim at arthrodesis at 150° to 160°.

*Ankle.* In bad fractures, arthrodesis may have to be aimed at, in which case the calcaneus must be united to the talus, as well as the talus to the tibia and navicular.

*Vertebrae.* Old fractured vertebrae are generally met with as compression fractures; months or years after the fracture the body of the vertebra may start absorbing and collapsing into a wedge-shape. If untreated at this stage, further collapse and augulation is likely to take place, and the wedge may be forced backwards so as to compress the cord and cause nervous symptoms. It is when these have already started that most patients seek surgical relief. I have dealt with a large number of these cases here, and am convinced that a decompression laminectomy is the treatment of choice, following by a plaster in lordosis, applied by the methods described by Boehler or Watson Jones, and kept on for 4 months. In cases with but little evidence of nervous lesions, plaster alone can be tried; but if the nervous lesion is not relieved at all in 3 months, decompression laminectomy is indicated.

*Patella:—*

(1) *Ununited.* It is usually best, if the fragments are widely separated, to excise

them and repair the retracted quadriceps tendon with fascial sutures from the fascia lata. The stitches must be drawn as tight as possible and the leg put up in plaster in full extension for 8 weeks.

(2) *Adherent to femur.* Excise the patella, and free adhesions of the quadriceps tendon to the femur, by bending the knee to a right angle. Then suture the quadriceps with fascial strips, covering the hole in the joint, left by the patella as far as possible. Immobilise for 3 weeks in full extension, and then take off plaster and allow active movement. Recovery of movement should be complete in 3 to 4 months. This treatment is simpler and more reliable than arthroplasty with fascial graft between patella and femur.

*Volkman's contracture.* Never try tendon lengthening. Adhesions and stiffness are almost invariable sequelae. The only two operations possible are:—

(1) *Shortening of radius and ulna.* Must be morticed and wired, so as to render them firm, or plaster will have to be applied so long as to make treatment impossible for many days; so it is better to do the following:—

(2) *Detachment of all involved muscle from their origin,* this being allowed to slide down the ulna and radius until new attachments are formed at a suitable level. During this operation the median nerve can be freed from adhesions and compression between the two heads of the pronator teres.

*Stiff fingers.* The numerous different appliances that have been devised for relief of this common and serious disability are themselves an indication of the great difficulty of treating these. Boehler advocates a stitch through the pad of each finger-tip fastened to a spring extension the other end fastened to an adjustable malleable metal (soft iron wire) rack attached by plaster to the wrist.

Massage, our enemy in so many conditions, may be our friend here. Hot bath (114° F. for ½ hour followed by active and very gentle passive movements) are sometimes useful. Occasionally movement under anaesthetic,—another thing to be avoided in almost all other joints.



conditions due to injury,—is beneficial, but must never be done more than once, and must be followed at once by active movements, aided by faradic stimulation. This latter is useful in all cases as a preliminary to the surgical treatment of joints; as ankylosis or immobility for many months causes degeneration of all muscles, and renders the patient incapable of doing those active movements which are our sheet anchor in the after-treatment of these cases.

### A FINAL WORD

Fractures heal much more soundly and rapidly in a healthy body. This means that as much exercise and movement as possible of all parts of the body (except

the bone or joint actually fixed by plints or plaster) must be undertaken.

Good food, ample vitamins (especially C and D), and extra calcium are advisable.

In a patient whose fractures unite slowly, Liq. Aluminum Acetate is a useful adjuvant to firm union, taken 4 times a day for 2 or 3 months.

In old compound fractures, the possible lighting up of old sepsis and even of tetanus must be remembered; proflavine and sulphathiazole powder is a good prophylactic, used freely in the operation wound, and allowed to remain and be sewn up inside the wound.

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## "AN ADDITIONAL TEST HELPING IN THE DIAGNOSIS OF CHRONIC CHOLECYSTITIS"

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It is now universally believed that a diseased Gall bladder is one of the most frequent organic causes of chronic dyspnoea.

Of the pathological states of the Gall bladder that which mostly concerns the practitioner is cholecystitis and that too chronic. It is a slow, smouldering chronic inflammatory change affecting the wall of the Gall bladder. The cause is infection through the systemic circulation in the vast majority of cases. The prevailing belief is that *B. Coli* from intestinal lesions or streptococci from the throat gain entrance into circulation, pass from lymphatics, veins, heart and then via the hepatic and cystic arteries, get implanted into the deeper layers of the Gall bladder wall. There they set up chronic fibroplastic response ultimately damaging the structure to such an extent that it loses its physiological function of concentrating bile to one tenth of its volume and to add

mucus to it and aid in the absorption of cholesterol from bile and perhaps excrete it on occasions. Further effects are reflex gastric symptoms of vague distention, pains in the upper abdomen specially after dinner and flatulence. This is explained by the fact that both Gall bladder and stomach are supplied by the nerves partly from the vagus and partly from sympathetic related to the ninth dorsal segment of the cord. The focus of internal sepsis thus established in the Gall bladder may react injuriously by toxic absorption on the cardiac muscle and the body generally. Very frequently this disease is associated with a recurrent or chronic Appendicitis and inflammation or ulceration of Pyloro-Duodenal region forming with them the abdominal triad of diseased Gall bladder-Pyloro-Duodenal region and the appendix. The vascular and Lymphatic connections of these three regions are closely associated.

While trying to investigate thoroughly the Biochemistry of blood in cases of diseased Gall bladder in our Wards and Surgical Research Laboratory we came across a unique experience, that is, the sufferers from chronic cholecystitis show marked cholesterol retention on doing what we call *cholesterol tolerance test*.

The estimation of cholesterol in blood falls into two categories, in one the whole blood is taken and the amount estimated while in the other case the cholesterol is estimated in the separated plasma. In India the work was carried out by Major T. C. Boyd and A. C. Roy (1929). They estimated the blood cholesterol of 100 cases and found the minimum value of 82 mgm. and the maximum 184 mgm., the average coming to 116 mgm. In other countries many workers have worked on this and their values are decidedly higher than those found here. Robinson in 1929 (Lancet) gives the average value of 151 for whole blood and 142 for the plasma. Gardner estimated by Digitonin method and gives the figure of 169 mgm. as average of 43 cases. The figures given by Wester and Kent are the highest. They give the average value as 182 in their 52 cases. The figures were ranging between 117-297 mgm. In our work we have estimated the cholesterol in separated serum; the colorimetric method was employed for this. Cases were taken from the wards. The estimation was done in most of the cases on empty stomach in order to eliminate the dietetic factor.

This work was done in our Surgical Research Laboratory by Dr. R. C. Pande, M.B.B.S.

The estimation was carried out on 86 cases. The minimum figure was 73 mgm. in a child aged 10 years and the maximum was 250 mgm. in an old man of 60 suffering from enlarged prostate with secondary vesical calculus, the average coming to 145.9 mgm. The table and the graph show comparatively the number of cases which had their serum cholesterol within a certain limit.

Serum Cholesterol	No of case	Percentage
Below 100 mgm.	4	4.7%
Between 100-119 mgm.	15	17.4%
" 120-139 "	25	29.1%
" 160-179 "	11	12.8%
" 180-199 "	10	11.6%
" 200-220 "	5	5.8%
Above 200	2	2.3%

In our series of cases the reading is higher than that found in the whole blood in India by other workers but is approaching the values obtained in other countries

The ingestion of food rich in Cholesterol for some time has been known to produce an increase in the blood cholesterol Gardner and Lander in 1913 (quoted by C. Lyons 1931) carried out experimental work on cats and were able to produce hypercholesterolemia after giving a large amount of cholesterol to eat on a single occasion. In dogs the systemic blood fat begins to rise 1 to 2 hours after a meal and reaches its maximum after 6 hours (S. Wright). In human beings it has been the aim in the present work to study the changes in the amount of cholesterol in the blood after a single ingestion of fatty diet and to compare it with the results so obtained in cases of cholecystitis. At the very outset it may appear that the test of giving fatty diet may not be safe in cases of cholecystitis but fortunately in this series of cases no complication or trouble occurred. The diet which has been prescribed does not contain such an excess of fat which can upset the patients but has enough of cholesterol in it to make the estimation desirable. The test need not be done in cases of acute cholecystitis in which the diagnosis is obvious. It is certainly very helpful in the obscure and chronic cases. In acute cases if one is particular the test should be applied after the acute symptoms have subsided and the patient is allowed solid diet.

#### METHOD.

The patient whose cholesterol metabolism is to be studied is not given any food after 9 O'clock the previous night. Next morning about 2 c.c. of unoxalated blood is collected at 6 a.m. in a clear dry test tube. Every care is taken to prevent

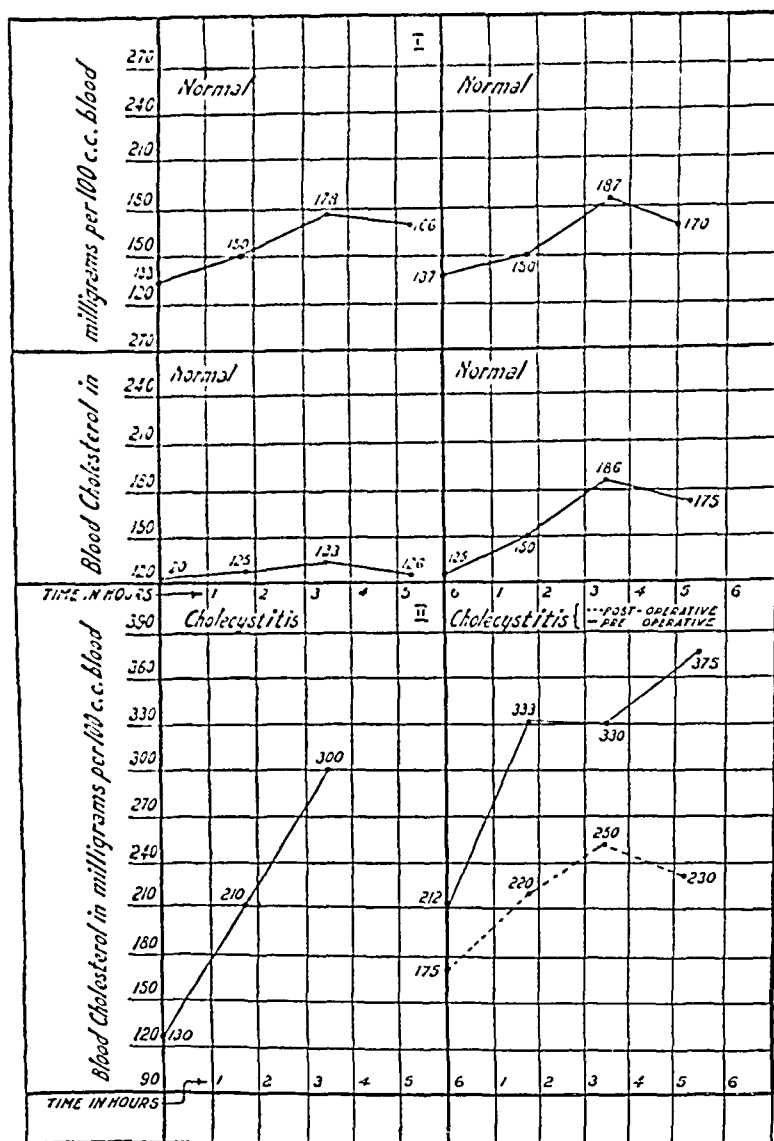


Fig. 1

haemolysis of blood (by use of dry sterile all glass syringes).

At about 8 a.m. or even earlier if it can be managed the patient is given 12 ounces of milk and 2 ounces of butter to eat on empty stomach. Three samples of blood are collected after every  $1\frac{1}{4}$  hours. During this period patients should not be given anything to eat, but if they feel too thirsty they can be given a small amount of water to sip during summer months. The collected blood is allowed to stand in

an incubator at  $37^{\circ}\text{C}$  for half an hour in order to separate the serum. The serum is taken in a small tube and centrifuged. 0.2 c.c. of the clear serum is mixed with a mixture containing 9 c.c. of absolute alcohol and 3 c.c. of ether. It is shaken well and left for 20 minutes and later on centrifuged (2,000 to 3,000 rounds per minute) again till the fluid becomes clear. The clear fluid is poured in a beaker and is allowed to evaporate slowly. Cholesterol is left behind. The dried cholesterol

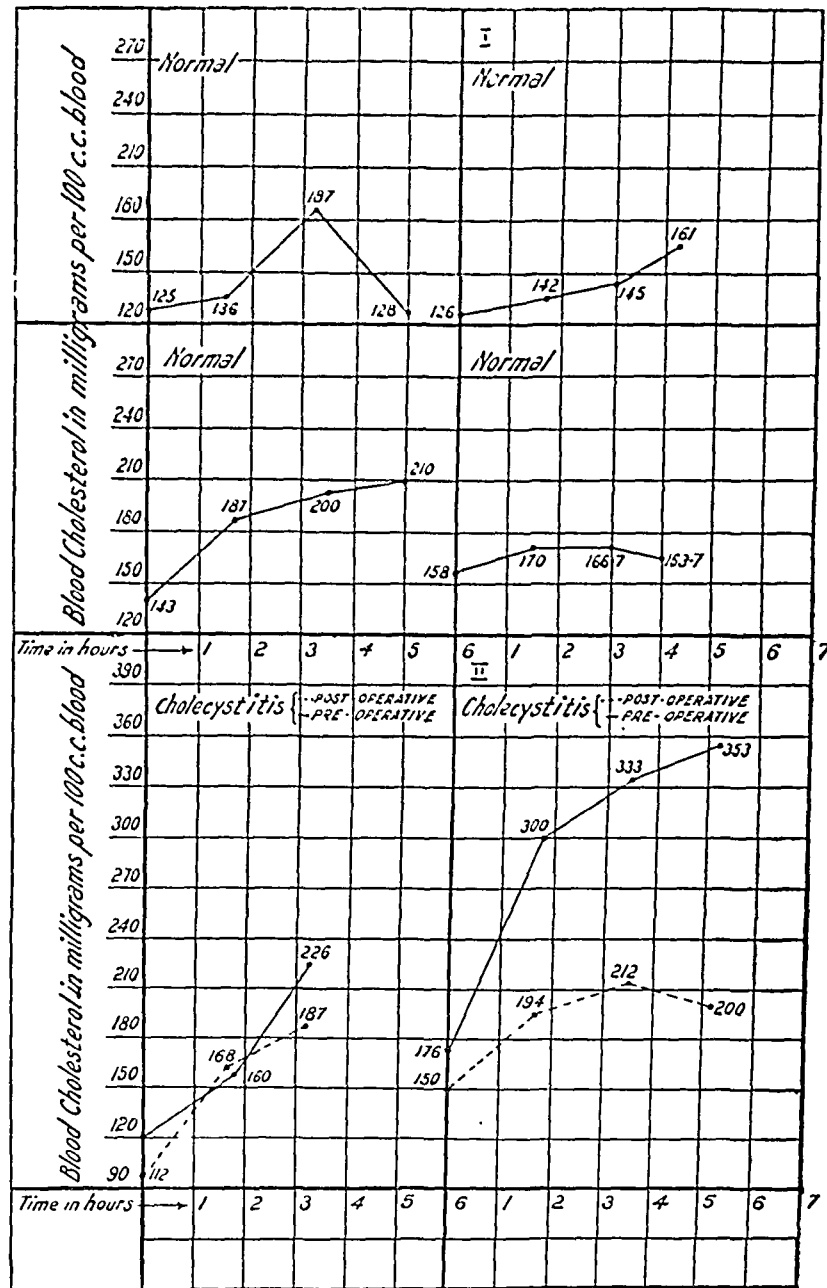


Fig. 2

is dissolved in 5 c.c. of chloroform. The colour is matched in a colorimeter by Leiberman and Burchard method by adding 2 c.c. of acetic anhydride and 0.2 c.c. of sulphuric acid, and comparing this colour with a standard containing 0.08 mgm. of cholesterol in chloroform per c.c. 12 patients of different diseases have been selected at random from the wards. Each estimation takes roughly 6 to 8 hours. Colorimetric methods cannot claim the degree of accuracy obtained by gravimetric methods by Digitonin precipitation

but a series of observations done by the same observers in one time keep their comparative value unimpaired.

It was found that 11 out of 12 cases showed the maximum rise in cholesterol level below 80 mgm; only in one case the figure was high. The average comes to be about 52 mgm. Taking these figures as our average we proceeded to work on cases of cholecystitis. Seven cases of gall bladder disease could be studied out of which 6 were cases of chronic cholecystitis and one was a case of cancer gall bladder

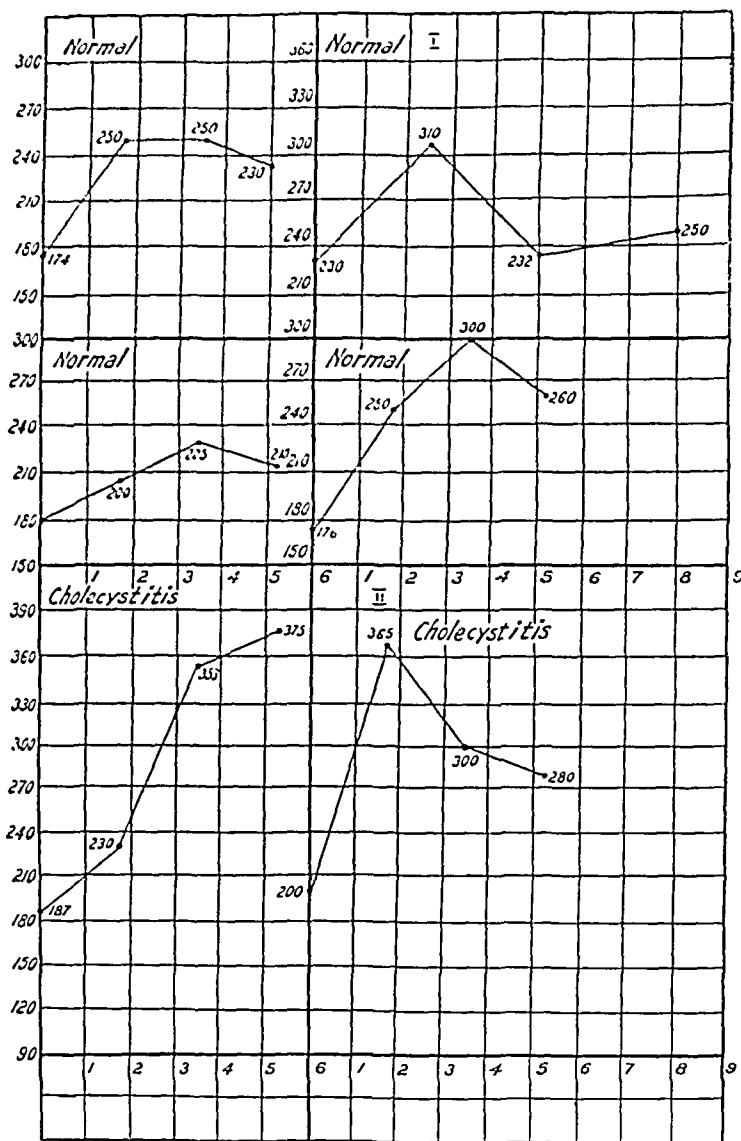


Fig. 3

as proved on the operation table. In three cases the cholesterol metabolism could be studied both before and after operation and it was noticed that the rise in the level was not so high after the operation of removal of the diseased gall bladder.

Now if we compare tables we find that after the diseased organ is removed from the body in cases of cholecystitis the metabolism curve again becomes low like that of other normal people. It can be judged by comparing the graphs of patients who

have been operated. By the above test if the rise of cholesterol is between 100 to 150 mgm. the case is probably one of cholecystitis but if the rise is more than 150 one should be inclined to think that it almost positively is a case of cholecystitis and this adds to the existing methods of confirming diagnosis of chronic cholecystitis.

By comparing the tables one is forced to think that the marked rise in the level of the serum cholesterol in the table is cer-

tainly due to the diseased condition of the gall bladder. In all the first six cases the rise was more than 100 mgm. the minimum being 106 mgm. while the maximum was 188 mgm., the average coming to 161.5 mgm. The seventh case was of cancer gall bladder and in this case the rise was only 75 mgm. though the fasting serum cholesterol was 300 mgm. which was due to jaundice. So the conclusion forces itself

that it is only in the chronic inflammatory conditions of the gall bladder that there occurs marked rise in the level of serum cholesterol while in case of new growth this was not noticed.

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### RADIATION TREATMENT OF CARCINOMA CERVIX UTERI

(With follow up report on 72 cases treated during the period 1935—1943)

by DR. P. RAMA RAU, D.M.R. (Vienna), The Madras Radiological Institute, Kilpauk, Madras.

The first phase of treatment of Carcinoma of the cervix was surgical. The second or radium phase developed as a natural sequence of unsatisfactory surgical experience. The third phase consisting in the addition of adequate external Roentgen irradiation to the use of radium, followed the realisation that control of lymphatic involvement of the parametrium is the most important factor in the management of these cases. This was naturally an outcome of further observations of cases treated and the recurrences that occurred in the lymphatic glands. In

cases of accidental deaths after radium application for Grade I carcinoma of the cervix autopsy revealed metastatic involvement of even the sacral group of glands, so that it is felt necessary to treat even Grade I cases with adequate external X-rays, as well as local radium applications. Success depends on the maximal doses being given at the first instance alone. In our own experience, most of the cases that came into the clinic in the early years, were advanced recurrences in glands after radium treatment with none at all, or not adequate enough of deep X-ray treatment externally. I briefly give the classification of cases and results.

Of the 34 cases belonging to Groups I & II, two were lost sight of within one year (1936 cases). All the others are alive and were checked up to June 1945. This group includes one case who had in 1941 post-operative radiation following vaginal hysterectomy. There was accidental damage to the bladder wall and a VVF. This was repaired six months after radiation and the patient is well to-day. A second case had radium outside in 1941 and no deep X-rays. She came in 1943 with a lump (recurrence in sacral glands) and since receiving external deep X-rays is doing well to-day. Both these were Grade I cases.

	No. of cases.	Alive for in years.										Alive total
		2	3	4	5	6	7	8	9	10		
Grades III & IV. 38 including 16 recurrences after previous radium treatment only.	38	2	3	-	1	2	1	-	1	-	10	

Out of 38 cases belonging to Grades II & IV, 28 died within one year; of these 1 were recurrences after previous radium but no X-Ray therapy. Excluding these 1 cases all of whom were dead within one year, ten out of the remaining 22 are alive for varying periods. One of these Grade I cases is interesting: Mrs. P. P. 49, admitted 16-3-'38—Large fungating growth—received 4000 r 200 K.V.-X-rays and 6000 mg-hrs of Radium; On 5-8-'40 she returned having

No. of cases.	Alive for in years.									Alive total.
	2	3	4	5	6	7	8	9	10	
Grades I & II 34	9	4	4	5	-	5	1	3	1	32

had a large haemorrhage. Local condition: Dome of vagina closed and cervix atrophied; parametria free. Tissue from uterus showed no evidence of malignancy. 50 mgms of radium were inserted and kept in for 24 hours. She was all right on 1st February 1943, reported herself for sciatica. Radiography revealed spondylitic changes; there was no local recurrence; laparotomy revealed secondaries in front of the 1st piece of sacrum. It was considered best to leave her alone. She died in September 1944. Lived for about 6½ years.

It is, therefore, essential that the pelvic lymphatic system including hypogastric, obturator, ureteral and sacral glands should all be adequately irradiated about the same time as radium is applied. A technique of combined radium and external deep X-ray developed by us has been very satisfactory as the above results show, especially, after the installation of high voltage apparatus of 400,000 volts in 1938. The whole combined course of treatment takes four to five weeks. There was no need to break treatment except in cases where occasionally complications arose. A supporting therapy with liver extract, iron and Vitamin B (last, in fairly large doses of 25 mgms. parenterally daily) has minimised blood changes and Roentgen sickness. Weekly blood counts have shown no change except some drop in the WBC which returns to normal within 3 or 4 weeks after cessation of radiation therapy. With the higher voltage, there has been no complications like diarrhoea and extreme sickness nor the skin burn found with the application of lower voltages like 200,000 or 180,000.

#### METHODS OF RADIATION:

There are several methods of radiation therapy, the more commonly adopted being, what is known as the "Stockholm" or "Paris" methods and their modifications. It chiefly consists in putting radium into the fornices with the colpostat in addition to the cervix proper to enable adequate irradiation of parametria. Additional external radiation is also given. External therapy consists in irradiating through 4 or 6 fields around the pelvic girdle, each of which receives 2000 r (2 fields daily, each field receiving 200 r),

with tension of 200,000 volts and 1 or 2 mm. Cu.filter. Internally 6,000 to 8,000 mghrs. of radium is applied half intracervically, and half in the vagina. This is done in two sessions, three weeks apart. Some apply radium after deep X-ray therapy, others follow radium with deep X-rays. The tendency now is to prefer giving deep X-rays first and when the tumour has shrunk, follow up with radium. I shall not go into further details of these methods in a short paper like this as there are plenty of observations published by various workers in Radiological literature.

I am using since 1938 a modified method of what is followed at the Mayo clinic and feel gratified with the results. This consists in applying the radium at weekly or six-day intervals. First dose is 1,200 mg-hrs. or less, second, 2,400 mg-hrs. or less, and a third, 2400mg-hrs or more depending on the reactions, to make a total of 6000 mg-hrs, two-thirds of the dose intracervically, and a third in the vagina against the external os. During the interval between the radium applications, external radiation with 400 k.v., 5 mm. Cu.+1 mm. Al.filter through a hypogastric field 15 x 15 cm. in daily doses of 200 r to 300 r to make a total of 3200 r to 4000 r is given. This will afford adequate irradiation of pelvic lymphatics and eliminates the necessity for application of radium to the fornices. The higher voltage also eliminates unnecessary irradiation of normal tissues which will be subjected to radiation when lower voltage of 200,000 and multiple field technique is adopted. (Radium: gamma rays 0.0175 A.U.; 400 K.V. 0.05 A.U. or about three times longer wavelength than gamma rays from Radium). There will be a cumulative radiation effect in the pelvis by this method, reaching the optimum concentration around 4 weeks or so. The general principle is to spread 5 to 8 erythema doses in the pelvis.

All cervical cancers are infected growths, and it is necessary to clear up the secondary infection before radium is applied; as else, high febrile reactions invariably follow. We usually start with external deep X-rays for the first 4 to 6 days, with daily vaginal washings with mild antiseptic douches, and then make

the first application of radium. This is found adequate and no febrile reactions occur, particularly as the first radium dose is only 1200mg-hrs. or so. In cases of cauliflower growths, Radium on a wax mould to fit the lesion is applied (dose of 1200 mg-hrs.); this is followed by the administration of the entire dose of external radiation. At the conclusion of external radiation, one invariably finds the cervix in a suitable condition to make an intracervical application of radium. By plugging the vagina with about 4 yards or so of six-inch gauze, radium is prevented from slipping out of position and the bladder and rectal walls are held away from the radium capsule. We have had no VVF or RVF in our series. Isodose curves will show how distance from source of radiation is the only method of saving rectal and bladder walls, as the radiation reduces in intensity from its source by what is known as "the inverse square law."

If at a distance of 1 cm. from the source, radiation is 100%, at 2 cm. it becomes 23.5% ; at 3 cm. it is 9.2% ; at 4 cm. it is 5.5% ; at 5 cm., 4% and at 6 cm. it is only 2.0%.

At the Radium Hemmet, Stockholm, a routine cystoscopic examination is done; if prominent vessels are noticed it is considered as a warning of probable early involvement of bladder wall.

In Grades III & IV, only high voltage 400 K.V. external radiation is given to a sum of 6000 r by hypogastric and sacral fields alternately. After an interval of two months a small dose of radium, 2400 mg-hrs. is applied intracervically if conditions permit. Else, one has to be satisfied with the results of external radiation only I have already mentioned our results.

A question often asked is the problems concerning treatment of cancer cervix associated with pregnancy. I have no personal experience in my clinic, but feel that an extract from the report from the Mayo Clinic may be given here.

"A study of 3570 cases of carcinoma of the cervix observed at the Mayo Clinic in approximately 32 years revealed that pregnancy was present in 26, or 0.7%.

"No definite conclusions can be drawn concerning the relative value of irradiation therapy; however, it appears that operation is preferable in cases in which the lesion is operable and that supplementary irradiation increases the percentage of good results. This is in contrast to the relative value of irradiation therapy and hysterectomy in cases of carcinoma of the cervix in the patients who are not pregnant.

"If the extent of the lesion permits operation and if the fetus is not yet viable, total hysterectomy is followed by irradiation; if the lesion is operable and the fetus is viable, cesarean section is followed by panhysterectomy and postoperative irradiation. In cases in which the lesion is non-operable and the fetus is viable, cesarean section is followed by irradiation; in cases in which the lesion is non-operable and the fetus is not viable, sufficient irradiation is employed to treat the lesion; incidentally, abortion occurs. When the lesion is operable, total abdominal hysterectomy has produced the best results. In 57 per cent of the cases in which this procedure was employed, the patients were free of recurrence five years after the operation."

### HORMONES AND MALIGNANT DISEASE

In the management of patients with skeletal metastasis from breast cancer X-ray castration was advocated by Ahlbom as early as 1930, the effect of such treatment being to greatly reduce the circulating estrogen. Lacassagne and others suggested treating these cases with androgen. The pronounced atrophy inducing effect of the male hormone on the ovaries is well known and Beecham (Dec. 1943) reported relief from pain and general improvement in some cases of advanced ovarian tumours and two cases of Grade IV cancer cervix by androgen therapy. I have as a routine adopted X-ray castration in all cases of cancer of breast referred to my clinic since 1937. I have not tried androgen therapy so far. Apparently it is worth trying the male sex hormone as an adjuvant therapeutic measure in malignant diseases in women, not only when the breast is involved, but also in



cancer of the cervix and tumours of the ovary. It is perhaps not wrong to assert that the comparatively unfavourable course taken by cancers in young women is due to the active condition of the ovaries and the large amount of estrone in the circulation. Reports of cases of secondaries from prostatic cancer that have improved with Stilbestrol are forthcoming in recent literature. This opens a new vista for thought—whether we could employ the neutralising effects of the female sex hormone in malignant diseases of the male and *vice versa*.

In conclusion, I must say, Radiation therapy properly planned, for early cases of cancer cervix may give us such gratifying results at present times, if only we keep an open mind as to measure and not have dogmas. The earliest case that came to the clinic sought medical advice around six to seven months after appearance of symptoms—two chief symptoms being 'blood stained discharge' after coitus and

'menorrhagia' of varying duration. The success in Grades I & II and in a few cases of advanced type (excluding those with recurrences after previous radium only) should certainly encourage us to follow on the lines adopted.

No. of cases.	Alive for in years.										Alive total.
	2	3	4	5	6	7	8	9	10		
Of the total No. of 72 (deducting the 16 recurrences after previous Radium only elsewhere) we have 56 cases in all groups. Of these 42. are alive.	11	7	4	6	2	6	1	4	1		42

All groups together 3 year survivals: 31 out of 56, or 56%, and five year survivals, 20 out of 56 or 36%.

A complete list of the 72 cases treated is appended.

Year.	No.	Name.	Age.	Grade.	X-ray Dose.	Radium Dose.	Remarks.
1935	1	Mrs. B.	44	I	3200 r	4800 mghrs	lost sight of 42 — 6 yrs.
1936	2	Mrs. A. V.	40	I	2400 r	4800	O. K. 9 yrs.
"	3	Mrs. P. K. A.	45	I	2400 r	3600	" "
"	4	Mrs. S.	35	I	3200 r	4800	" "
1937	5	Mrs. A.	43	I	2400 r	4800	" 8 yrs.
1938	6	Mrs. T.	52	I	3200 r	3200	" 7 yrs.
1940	7	Mrs. S.	48	I	3200 r	6500	" 5 yrs.
1941	8	Mrs. S.	30	I	4800 r	2800	" 4 yrs.
1942	9	Mrs. B. P.	35	I	3200 r	6000	" "
"	10	Mrs. A.	41	I	4800 r	5200	" "
"	11	Mrs. F.	28	I	3200 r	2100	" "
1943	12	Mrs. A.	41	I	3200 r	4992	" "
"	13	Mrs. M.	41	I	3200 r	4560	" "
"	14	Mrs. D.	35	I	3200 r	4900	" "
"	15	A	45	I	3200 r	4800	" "
"	16	Mrs. S.	70	I	3200 r	5760	" "
"	17	S	68	I	3200 r	4800	" "
1941	18	Mrs. J.	45	I	4800 r	After hysterectomy — accidental VVF. Repaired in 6 months after deep X-rays. O.K. now.	
1943	19	M	45	I	3600 r	Ra. elsewhere in 1941—no deep Xrays. Recurrence in sacral glands—O. K. now.	

Year.	No.	Name.	Age.	Grade.	X-ray Dose.	Radium Dose.	Remarks.
1935	1	K	30	II	2400 r	2400 mghrs	O. K. 10 yrs.
"	2	M	40	II	2400 r	1800 "	lost sight of within 1 year
"	3	A	55	II	2400 r	9590 "	"
1938	4	R	31	II	6000 r	6300 "	O. K. 45 — 7 yrs.
"	5	L	65	II	6400 r	7100 "	"
"	6	D	41	II	3200 r	6300 "	"
1940	7	B	50	II	7200 r	1000 "	O.K. 45. Note small dose of Ra. short vagina menopause 8 years ago infantile uterus, long rigid cervix felt per rectum.
"	8	N	50	II	3200 r	6200 "	O. K. — 5 yrs.
"	9	C	38	II	5600 r	5520 "	"
"	10	K	40	II	7800 r	1200 "	O. K. — 5 yrs.
1941	11	K	46	II	4000 r	5500 "	" 4 yrs.
1942	12	M	36	II	3600 r	6000 "	" 3 yrs.
1943	13	S	31	II	4000 r	6175 "	" 2 yrs.
"	14	P. V.	41	II	3200 r	6210 "	"
"	15	B	31	II	3200 r	5950 "	"
1935	1	B	60	III	5600 r	2800 "	Dead — 19-1-'36.
1936	2	R	30	III	9800 r	6300 "	O. K. — 9 yrs.
"	3	K	36	III	—	4800 "	Dead—Nov. '38, 2 yrs.
1939	4	S	30	III	1200 r	3456 "	Lost sight of.
"	5	B	58	III	2400 r	3800 "	O. K. 45 — 6 yrs.
"	6	L	48	III	3600 r	5750 "	"
"	7	A	54	III	3200 r	Ra. elsewhere	—recurrence—lost sight of.
1940	8	M	41	III	3200 r	6360 mghrs	O. K. 45—had a mass to be felt per rectum which burst into the rectum 4 months after treatment.
1941	9	B	42	III	4000 r	Ra. elsewhere	—Recurrence—lost sight of.
1942	10	D	48	III	5600 r	3000 "	O. K. 45 — 3 yrs.
1943	11	S	36	III	9400 r	3800 "	Dead 2-7-'43.
"	12	B	38	III	5600 r	1800 "	Died within one year.
"	13	GKS	34	III	4800 r	5800 "	Died in June '45 of acute abdomen—no recurrence —2 yrs.
"	14	D	35	III	4800 r	1260 "	Died — Jan. '44.
"	15	K	40	III	4000 r	5500 "	O. K. 45.
"	16	R	34	III	4000 r	5650 "	Died of peritonitis.
1935	1	M	58	IV	3200 r	1410 "	Lost sight of.
"	2	A	—	IV	3200 r	1800 "	Dead 17-2-'36.
"	3	B	60	IV	5600 r	2800 "	Dead 19-1-'36.
1936	4	R	40	IV	2400 r	Ra. elsewhere	—Recurrence—lost sight of.
"	5	E	41	IV	3750 r	Ra. elsewhere	—Recurrence—died 23-6-'36
"	6	P	48	IV	4800 r	3750 Mghrs	Lost sight of — July '39.
1937	7	I. C.	43	IV	2400 r	Recurrence after Ra. outside VVF	—died within one year.
1938	8	S	54	IV	5600 r	3560 mghrs	Lost sight of.
"	9	P	49	IV	4000 r	7200 "	Died 44 — 6½ years.
1939	10	T	57	IV	6400 r	1550 "	Died within one year.
"	11	M	24	IV	4000 r	600 "	Lost sight of.
"	12	P	40	IV	2400 r	1380 "	"
"					2400 r	2375 "	"
"	13	S	35	IV	2400 r	4250 "	Died June 1940.
1940	14	D	59	IV	2000 r	Ra. elsewhere	—Recurrence.
"	15	B	38	IV	6800 r	"	Died 1941
1941	16	R	35	IV	5600 r	"	"
"	17	M	47	IV	4800 r	"	Died within one year.
"	18	A	54	IV	3200 r	Ra. elsewhere	—recurrence—dead.
1942	19	B	65	IV	4000 r	"	"
"	20	P	43	IV	8200 r	"	in 40—died within 1 year.
"	21	P	50	IV	4800 r	Ra. elsewhere	—Recurrence—dead.
1943	22	A	49	IV	6000 r	"	"

## IRREDUCIBLE COMPLETE PROLAPSE OF THE RECTUM

by DR. S. P. SRIVASTAVA, M.S., F.R.C.S. (Eng.), Medical College, Agra.

Complete prolapse of the rectum has been met with in U. P. among children, the middle-aged and old males and females alike. Females are said to be more often affected than males and a greater incidence of complete prolapse is observed in women who have suffered the strain of parturition than in those who have never borne children.

The cause of complete prolapse in children is in most cases stone in the bladder and constant straining at micturition invariably results in this condition. In two cases I have come across rectal polypus as the cause and in a few, chronic colitis and malnutrition.

The adult cases have been mostly subjects of chronic dysentery resulting in gross secondary anaemia and complete prolapse due to straining.

Apart from pregnancy there are two other causes which have been described: Many subjects are extremely stout and the increasing intra-abdominal fat would appear to be the causative factor. Some subjects are of the thin type and usually present well-marked signs of visceroptosis with perhaps inguinal hernia and general yielding of the abdominal wall.

None of my cases was excessively stout, and if so they were cases of partial prolapse in association with internal piles.

The view of Moschowitz that complete prolapse of the rectum is really a type of hernia is now commonly accepted. Yielding of the pelvic fascia takes place as a result of straining or increasing intra-abdominal pressure and owing to the firm attachment of the peritoneum to the anterior wall of the rectum, a sliding hernia takes place first of the anterior and then of the posterior rectal walls until finally the prolapse appears through the anus. Tuttle states that if the length of the prolapsed rectum is more than two inches it can be taken as certain that a hernial sac is present.

Complete prolapse is usually reducible; it descends with increasing frequency, coughing and sneezing bringing the prolapse down and finally it may appear even on standing or walking so that an invalid life has to be adopted. Bleeding occurs in large quantities through abraded mucous membrane. Irreducibility is a common complication, the cause of which is probably sphincteric spasm at first and later, oedema of the layers of the rectal wall. Omentum or small intestines have not been met with in the peritoneal pouch nor have there been symptoms of intestinal obstruction or strangulation.

The two cases of unreduced prolapse gave histories of the protrusion coming on suddenly during straining, all efforts at reduction failing. Reduction was tried under anaesthesia with no result. In both the cases there was no obstruction to the passage of faeces and flatus, but in one case there was retention of urine in the beginning.

In both the cases there was superficial ulceration of the mucous membrane and foul discharge, which cleared up by the use of antiseptic dressings. After waiting for about one to two weeks, the operation of Recto-sigmoidectomy had to be resorted to, conservative treatment having failed. In one case in our hospital prolonged short wave therapy was successful in reducing the prolapse. In my opinion, unless the case is attended to immediately it is difficult to reduce it because adhesions form between the layers of the rectal wall binding them together and the supervention of oedema makes reduction difficult.

Amputation of a prolapsed rectum was originally carried out as an emergency measure for irreducibility and threatened gangrene. Auffret performed the operation in 1882 on a case of this type. Mickulicz described in 1888 a series of 6 cases of amputation of the prolapsed rectum; the indication in his first case was an acute irreducible prolapse and the successful issue led him to extend the use of the

operation for cure of severe habitual prolapse of the rectum. Throughout his operation of circular resection the wound was irrigated with a dilute solution of carbolic acid, the peritoneum was opened and then closed by suture; the prolapse was amputated and the two intestinal walls were joined by deep sutures of silk which caught up all the layers of the bowel wall. At the end of the operation the suture lines were painted with Iodoform, the sutures were cut short and the bowel replaced. In the six cases reported by Mickulicz immediate healing of the wound and lasting recovery resulted.

Further cases of prolapse treated by amputation were described by Treves, Cunningham and by Sheldon, the latter in particular suggested several important details in technique. The credit for re-establishing the operation on a sound basis is due to Miles who coined the new term "Recto-sigmoidectomy".

The operation is preferably carried out under general anaesthesia but I have found spinal anaesthesia quite good though it is said that in the latter there may be accompanying contraction of the bowel wall, due presumably to the remaining vagal influence, making it difficult to deliver the prolapse fully.

The patient is kept in the lithotomy position and a circular incision is made 1" distal to the anal margin through mucous and muscular coats. The bleeding points should all be caught and tied. The peritoneum is opened for about 3" in front of the lax pelvic colon which is drawn taut over which it is sutured to the front of the pelvic colon. The latter is cut leaving an oval lumen which is sutured to the remaining portion of the rectal wall. Four mattress sutures are introduced at the four corners first and then the two walls of the bowel are sutured by a continuous layer of catgut. The suture line will be observed to recede to its proper position inside the rectum. A finger is passed to feel that the suture line is smooth and at this stage the funnel effect of the Dilated anus narrowing to the contracted pelvic colon is very remarkable. A firm pad of wool is applied and the patient is returned to bed, the foot of which is raised on blocks for 6 to 12 hours. The bowels are

made to act on the fifth day or so by giving an aperient, but no enema is given.

\* \* \*

CASES: (1) Name—B. aged 40 years, was admitted with retention of urine and irreducible prolapse of the rectum. An attempt to reduce the prolapse failed; hot or cold applications and short-wave therapy were of no avail. He was operated on under spinal anaesthesia and made an uneventful recovery. He had incontinence of urine for about a week after which the sphincters regained their tone. The bleeding on incising the walls of the rectum was very little. He was given sulphonamides, pre and post-operatively and intravenous saline and glucose. He had about half a pint of serum transfusion also.

In this case prolapse occurred for the first time and was irreducible.

(2) Name: T. Ram, aged 35, Hindu male; complained of unreduced prolapse rectum which occurred due to straining at stools. The prolapse used to be reducible but this time it was not. The prolapsed portion was oedematous and patches of necrosed tissue was present on its surface. Fomentations and short-wave were of no avail. He was operated on after about a fortnight and rectosigmoidectomy was done. The patient made an uneventful recovery and was discharged after about 3 weeks.

(3) One case of unreduced prolapse got itself gradually reduced by short-wave diathermy exposures after several days and no operative treatment was necessary. Such a course is possible only when perhaps there are no adhesions and as the oedema subsides the prolapse disappears. One feature with all these cases of unreduced prolapse is that they do not have any obstruction to faeces or flatus and the only care to be taken is to avoid sepsis by frequent antiseptic dressings.

(4) One case, aged about 40 years of reducible prolapse was operated on and rectosigmoidectomy was done; but owing to existing anaemia and general debility he could not sustain the shock of the operation and so succumbed as a result of it. Blood transfusion, which might have been beneficial was not available. He was a chronic case of colitis and his general constitution was of the thin type. The Lockhart-Mummery operation was a failure in this case as has been found in other cases too.

**Conclusion** — Rectosigmoidectomy is the treatment of choice in cases of unreduced prolapse when reduction is not possible even under general anaesthesia. The operation can safely be done under spinal anaesthesia after waiting for a few days for the superficial sloughs to be cleared away. Pre-operative treatment of anaemia with liver extract and blood transfusion is essential before operating by the Mickulicz technique for irreducible prolapse in Indians.

## A CASE OF CHONDROMA OF THE SCAPULA

by LT.-COL. C. R. KRISHNASWAMI.

T...Z, a Bengali Muslim aged 55 years, employed in a hospital ship as a coal trimmer, struck his shoulder about the 20th of October '44, against the side of the ship while it rocked in stormy weather. The M. O. who saw him at the time re-



Fig. 1.  
T-Z—

[Note the Swelling in the Infra Clavicular Fossa].

ports—"No fracture. The force, though trivial in itself, was important in bringing to notice a serious underlying pathological lesion."

He was evacuated and admitted to this General Hospital on 30-11-'44. The following were the findings here:—"A bony-hard irregular swelling was felt in the right infra clavicular region, in the position of the coracoid process and had probably been growing for some years. There was no tenderness or oedema over it. The patient had no referred pain. No prominence or swelling was noted on the dorsum of the scapula, while the tumour was palpable in the axilla and was of the same uniform bony hard consistency and knobbly. Abduction and external rotation of the arm were considerably limited, but other movements were full.

### X-RAY FINDINGS:

"A bi-lobed growth about the size of a tennis ball involving the neck of the scapula and the coracoid process. No evidence of fracture".

Clinical examination was otherwise negative. The urine was normal and the Kahn was negative.

Operation was performed on 6-1-'45 under gas and Oxygen general anaesthesia.

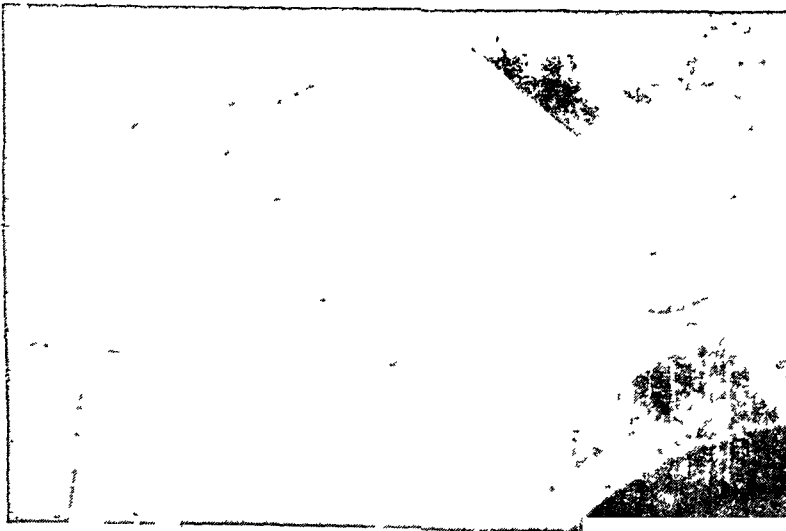


Fig. 2.

Skiagram Showing the Tumour.

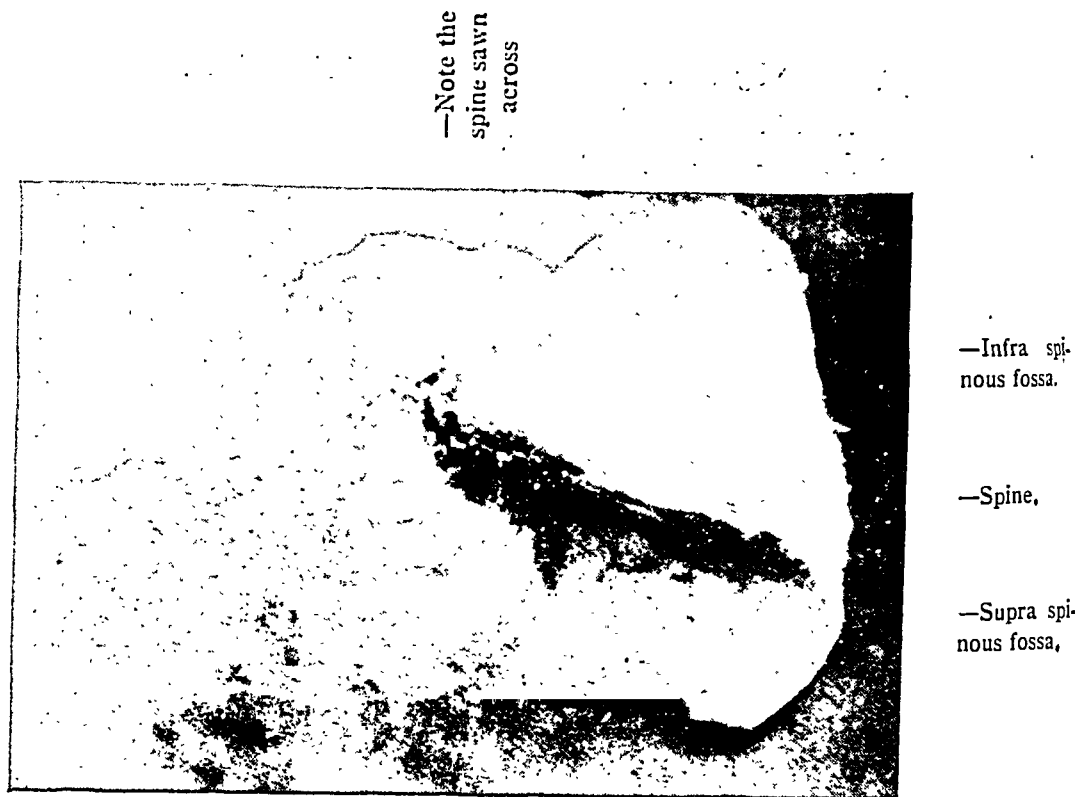


Fig. 3.

One View of the Excised Scapula.

The patient was put flat on the table, and a sand bag was placed under the scapula to open out the infra-clavicular region.

A vertical incision was made from a point lateral to the normal position of the coracoid process and extended down the delto-pectoral groove for  $2\frac{1}{2}$ ". The cephalic vein was avoided and the Deltoid muscle retracted. A prominent portion of the tumour could be seen with stretching of the structures in front of it. After the pectoralis minor muscle was divided, the depth of the axilla could be inspected, and the axillary artery was seen and the Sub-Scapular branch was identified and ligatured.

The short head of the Biceps and the Coraco-Brachialis were detached from the tumorous Coracoid process and the Subscapularis divided in front of the tumour and dissected from the growth as much as possible. As much of the anterior half of the capsule of the shoulder-joint as could be seen easily at this stage was divided.

A mop was then placed in the wound, and the skin flaps were brought together temporarily by tissue forceps.

The patient was now turned to the left so as to bring the right scapular region into view.

A "T" shaped incision was made over the scapula, the vertical limb along the vertebral border and the horizontal along the spine of the scapula. The flaps of skin and subcutaneous tissue were raised. The trapezius and Deltoid were detached from the spine up to the acromion process. The Levator anguli scapulae, both the Rhomboids and a few fibres of the Latissimus Dorsi at the lower angle of the scapula were next divided. Next the Supra-spinatus and Omohyoid muscles were divided at the upper border of the scapula and the supra scapular artery was ligatured. The Infra-spinatus was divided about its middle and the Seratus magnus was detached from the vertebral border. The scapular spine was sawn through at the beginning of the acromion process.



*Fig. 4.*

View Showing Unaffected Glenoid Cavity.



*Fig. 5.*

Another View of the Excised Scapula.



Fig. 6.

Tumour seen through showing areas of degeneration

The scapula was now freely mobile and lifted out after division of the Teres muscles, the long head of Biceps, Triceps, and the remaining portion of the capsule of the shoulder joint on the posterior aspect.

A careful inspection of the head and neck of the Humerus showed these structures to be normal.

The detached portions of the Trapezius and the Deltoid were brought together by a few stitches as well as also the Serratus and the Rhomboids.

The skin was sutured anteriorly and posteriorly and to complete the operation a drain was left in the posterior wound.

The operation was practically bloodless due to the primary ligature of the subscapular artery and the patient's general condition was excellent at the end of the operation.

The acromion process was left behind as it was not involved, and to give the deltoid and the Trapezius, a good purchase to act and to preserve the contour of the shoulder.

The post operative convalescence of the patient was absolutely uneventful and afebrile and the wounds healed by first intention.

Limb was put up in a Thoraco-Brachial plaster with the arm in abduction at 90°.

Report by Major MORGAN, R.A.M.C., Pathologist:—

*Microscopic*—The specimen is a scapula showing a large knobby tumour of cartilagenous consistency originating in the bone and forming large protuberances, above and below the spine of the scapula. On sawing this across, it has the appearance of a simple Chondroma.

*Histology*—Portions from the superficial and deeper parts of the growth show a Chondroma, with no evidence of malignant change."

*At the time of discharge, I am told that* he was able to abduct his arm to a right angle, more not being possible, internal rotation was possible to the full extent, external rotation being limited by about 15°.

It was unfortunate that during the absence of the writer on leave the patient was discharged from the hospital without a clinical photo to demonstrate the range of movements possible after operation, and a skiagram to show the disposition of the parts, and the position of resting of the head of the Humerus on the chest wall.

My thanks are due both to General P. H. Mitchner and Colonel G. R. Oberai who were kind enough to give me permission to publish this case.



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### The Annual Conference

The Seventh Annual Conference of the Association of Surgeons of India will be held in Mysore on 27th, 28th and 29 December, 1945. Dr. B. N. Balakrishna Rao, M.B.B.S., F.R.C.S., K. R. Hospital, Mysore, is the Local Secretary and all members intending to attend are requested to get into touch with him as early as possible.

### Registry of Sarcoma of Bone

It was decided at the last Conference that a Registry of Sarcoma of Bone is to be maintained under the auspices of the Association. Dr. V. R. Khanolkar of the Tata Memorial Hospital, Bombay, has very kindly consented to make the necessary Pathological study of Specimens. All Surgeons are, therefore, requested to send short but complete notes of cases of Sarcoma of Bones under their care to Dr. Khanolkar along with X-Ray and Clinical photographs, if any, and a piece of embedded tissue or two unstained slides. It is particularly requested that all Surgeons will co-operate in this endeavour.

### The Library

The attention of all members is invited to the Circular regarding the Library. A separate account has been opened and donations and subscriptions may be sent to the Secretary. Suggestions regarding books and journals to be acquired are welcome. Donations will be acknowledged in the Journal from time to time.

### List of Donors

(Since publication of the previous list)

Capt. V. L. Suryavanshi	..	Rs.	50	0	0
Previous total	..	..	3,457	0	0
Grand total	..	Rs.	3,507	0	0

### Subjects for Discussion

#### 7th Meeting:

##### 1. Traumatic Surgery of the Skull—

Opener: Dr. R. N. Cooper, Bombay.

Seconder: Dr. G. D. Kapur, Lahore.

##### 2. Enlarged Prostate—

Opener: Dr. S. R. Moolgavkar, Bombay.

Seconder: Dr. S. S. Anand, Lahore.

##### 3. Fractures of the Neck of the Femur—

Opener: Dr. B. N. Sinha, Lucknow.

Seconder: Dr. A. K. Talwalkar, Bombay.

#### 8th Meeting:

##### 1. Carcinoma of the Rectum—

Opener: Dr. C. P. V. Menon, Madras.

Seconder: Dr. E. J. Borges, Tata Memorial Hospital, Bombay.

##### 2. Carcinoma of the Cheek—

Opener: Dr. B. M. Joly, Delhi.

Seconder: Dr. K. M. Rai, Madras.

##### 3. Hare Lip and Cleft Palate—

Opener: Dr. S. C. Sinha, Calcutta.

Seconder: Dr. M. G. Kini, Madras.

#### 9th Meeting:

##### 1. Bone Tumours—

Opener: Dr. D. R. Meher Homji,  
Bombay.

Seconder: Dr. M. G. Kini, Madras.

##### 2. Intracranial Tumour—

Opener: Dr. A. V. Baliga, Bombay.

Seconder: Dr. R. N. Cooper, Bombay.

## 3. Burns—

Opener : Dr. M. R. Munawar Ali,  
Hyderabad.

Seconder : Dr. G. M. Phadke, Bombay.

## Prize Essay

The offer of a prize of Rs. 150 for the best Essay on "Infections of the Foot" is renewed. The following are the conditions:—

1. The competition is open to all qualified medical practitioners registered in India, who have been in practice for not more than 10 years after qualification.

2. The essay should be based on original work and should be written in English.

3. It should be type-written on one side of the paper only and should not contain the name or other indication of the identity of the competitor. Four copies should be submitted.

4. The name, address and qualifications, however, should be written on a separate sheet of paper and enclosed with the essay.

5. The subject is "Infections of the Foot" and the essay should reach the Secretary before the 1st October 1945.

6. The copyright for the winning essay will remain with the Association of Surgeons of India and will be published in the Indian Journal of Surgery. Other essays will be returned to the senders, if accompanied by stamped addressed envelopes.

7. The Governing Body may, at its discretion, withhold the prize if the essays submitted do not come up to the standard.

8. All communications regarding the above are to be addressed to the Secretary, Association of Surgeons of India, 'Binfield,' Kilpauk, Madras

C. P. V. MENON,

Hony. Secretary

# THE INDIAN JOURNAL OF SURGERY

Vol. VII

SEPTEMBER & DECEMBER 1945

Nos. 3 & 4

## ON THE ANATOMY OF THE INGUINO-HYPOGASTRIC AND INGUINO-FEMORAL REGIONS\*

by Y. APPAJEE, B.A., M.B.B.S. (Cal.), M.Sc. (Lond.),

*Department of Anatomy, Medical College, Mysore.*

### INTRODUCTION

For some years now, the writer and his assistants in this department have been observing in the local material, that the muscles—the internal oblique and the transversus—of the anterior abdominal wall, actually arise from the entire length of the inguinal ligament and not from its lateral part only as is described in the textbooks. The implication of this fact is far-reaching in that we have to discard the conventional description of the inguinal canal. We have often been unable to demonstrate to the students the ‘arching of the lower margins’ of these muscles to form the roof of the canal,—unless it be by removing their continuity with the ligament—and the several structures like the conjoint tendon, Hesselbach’s ligament, Thompson’s ligament, Henle’s ligament and so on.

It is seen from the survey of the available literature, that the anatomy of these regions has attracted the attention of the anatomists and the surgeons from very early times as it is frequently the site for varieties of hernia. The description of those regions given by the previous writers are many and varied. In recent times some authors have questioned the correctness of the conventional text-book descriptions.

\*This is an elaborated thesis of some of the views expressed at the Annual Conference of the Mysore Medical Association held at Bangalore in January, 1945.

### MATERIAL AND METHOD

Observations were made on fifty (50) cadavers of both sexes. The inguinal, hypogastric and femoral regions were carefully dissected by the writer and his assistants or by the students under instruction. Special dissections were done from the peritoneal aspect. The muscles and the fascia were examined by transillumination. A few full-term fetuses were also dissected. Lastly, transverse and sagittal sections of the regions in question were studied under the dissection microscope.

Many of our findings just corroborate the descriptions given recently by writers like Anson (1938) and Chandler (1944). Other findings are at variance with the text-book descriptions and with the observations of the writers on this subject mentioned above. A general description, based on the above study and considered to be the normal picture, is given below. Under each heading the variations from the type are also mentioned. The differences have no sex relationship. It is found further that the anatomy often differs on the two sides in the same subject.

### DESCRIPTION

There are three fascial layers superficial to the muscles in the anterior abdominal wall below the umbilicus. They are the two layers of the superficial fascia—the Camper’s and the Scarpa’s fasciae of the text-books—and a third fascial investment, which the American anatomists call the

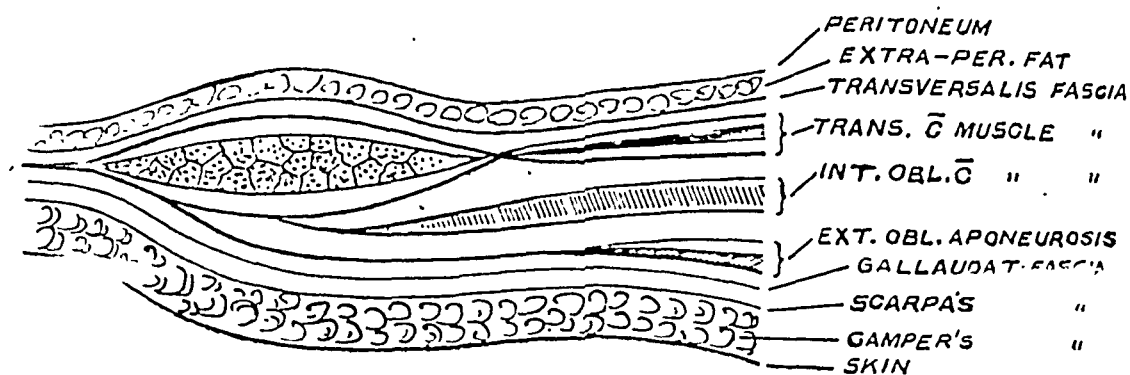


Fig. 1.

Tr. Section of Ant. ABD. Wall below Umbilicus.

fascia innominata of Gallaudat. This deep layer passes across the inguinal ligament into the thigh and blends with the fascia lata; medially it passes on to the penis to blend with Buck's fascia. Each of the muscles of the wall has, as well, an intrinsic connective tissue investment known as the muscle fascia. (Fig. 1).

### M. OBLIQUUS EXTERNUS

In the infra-umbilical region, this muscle is replaced entirely by its aponeurosis. This aponeurosis is invested on both sides by the muscle fascia. Two sets of tendinous fibres interlace to form this broad aponeurotic sheet. This passes in front of the M. rectus abdominis and its sheath to get inserted to the linea alba. It does not blend with the deeper layers and hence it cannot be said to contribute to the formation of the rectus

(Fig. 1). Lower down, near the crest, the transverse fibres are few and scattered so that the oblique set easily splits to form the crura of the external ring for the passage of the spermatic cord. The transverse fibres and the muscle fascia are stretched over the cord and carried into the scrotum as the external spermatic fascia. It is only after the removal of this layer that the so-called superficial inguinal ring comes into view.

The lower margin of the aponeurosis is greatly thickened and forms a grooved band towards the abdominal aspect, as it fuses with the aponeuroses of the deeper muscles. It forms a prominent arched

structure called the Inguinal or Poupart's ligament, due to its attachment to the fascia lata below. This inguinal ligament is broader medially and laterally as it fuses with the fascia pectinea and fascia iliaca respectively, thus forming semilunar margins bordering the femoral sheath on either side (Fig. 5).

Certain structures in this region are spoken of as extra insertions of this aponeurosis. They are (1) the pectineal part of Inguinal ligament or lacunar or Gimbernat's ligament (2) the pectineal ligament or ligament of Astley Cooper (3) Reflex inguinal ligament. I am of the opinion that the inguinal ligament represents not only the fused lower margins of the aponeuroses of all the three anterior muscles, but also the fused edge of the fascial investments of the posterior and anterior abdominal muscles in that region. More will be said about it when the formation of the femoral sheath is discussed. These so-called extra insertions like the lacunar ligament represent the fused pectineal fascia with the inguinal ligament. The reflex inguinal ligament is really the lowest oblique fibres of the aponeurosis of the other side interlacing through the linea alba and passing over to reach the pubic crest on the opposite side. The name is a misnomer. Very often it is absent.

### M. OBLIQUUS INTERNUS

In our series, the muscle arises from the entire inguinal ligament and not from its

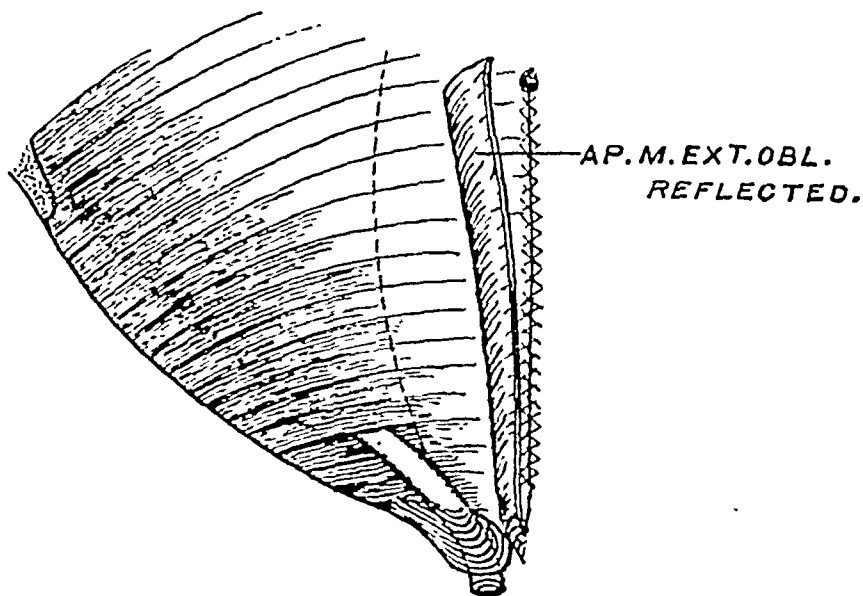


Fig. 2.  
M. Int. OBL. arising from entire Ing. Lig.

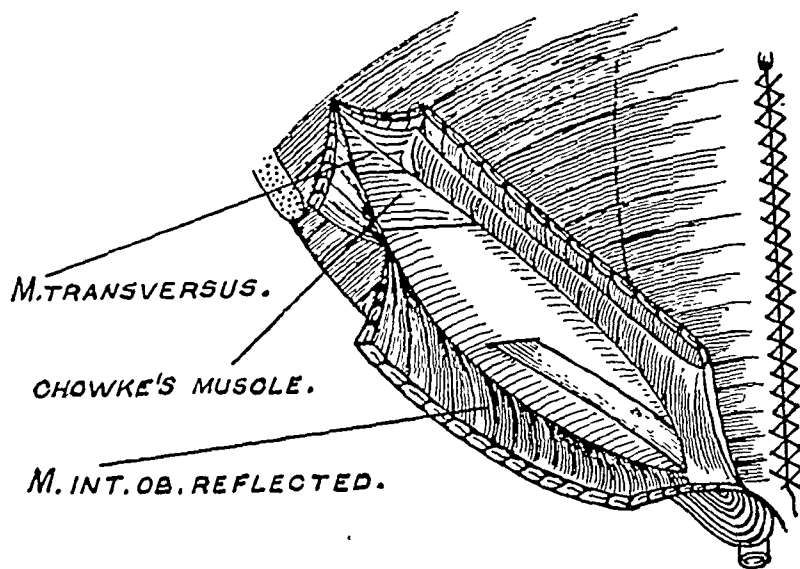


Fig. 2a.  
M. Transversus ABD. and Chowke's muscle.

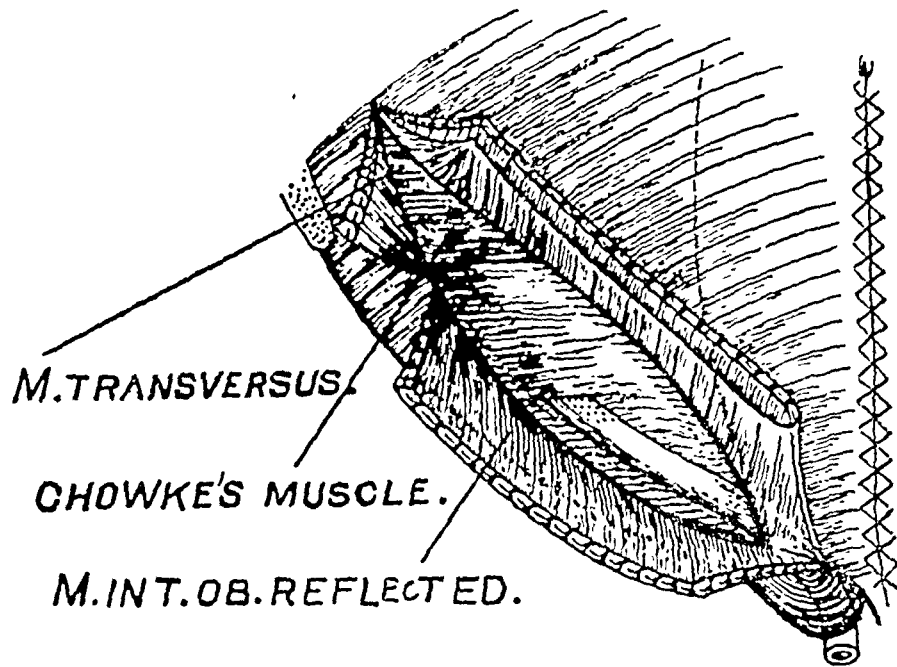


Fig. 2a.

M. Transversus ABD. and Chowke's muscle.

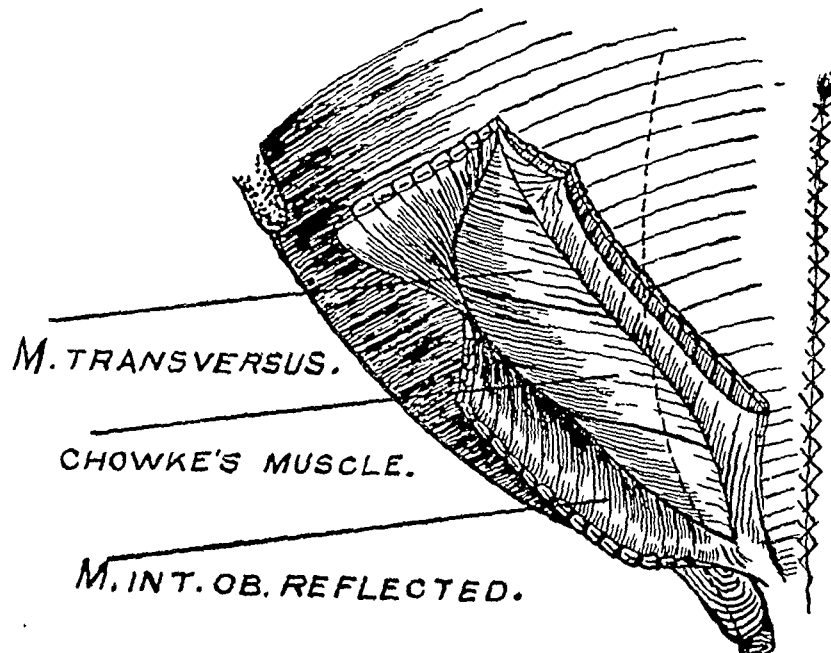


Fig. 2a.

M. Transversus ABD. and Chowke's muscle.

lateral half only as described in the books. As such there is no arch formation in its lower part. The lowest fibres, arising from the grooved upper surface of the inguinal ligament, pass horizontally across, to reach the linea alba in front of the rectus sheath. Often, muscle fibres are seen to reach beyond the external ring. The muscle arises from a wide area of the iliac fascia also. The muscle is often broken into bundles with intervening clear spaces of muscle fascia. Many a time it is blended with the *M. Transversus*. It is pierced by two nerves, viz. genital branch of the genito-femoral nerve and the ilio-inguinal nerve, which join the cord just before the latter pierces the external ring. The spermatic cord pierces this muscle just lateral to its exit in the external oblique and as it really evaginates the muscle, it carries a few muscle-fascicles and the muscle fascia as one of its coverings viz., the 'cremasteric fascia.'

In half the number of cases examined, irrespective of the sex, or the general musculature of the body, this muscle was thick and showed variable stratification. The deeper layer was broken into one or more fleshy bands which were first described by Chowke as accessory internal oblique muscles. This Chowke's Muscle is very variable. It may be present on one side only or present on both sides. Statistical analysis has not been worked out in our cases as to its presence or absence, the number and so on. When present, this muscle is always found near the level of the anterior sup: spine or above it. It has a separate tendon of insertion to the rectus sheath.

In only 20 per cent of our cases, the internal oblique was aponeurotic below the iliac spine. In no case was there any arched lower margin over the deep ring as described in the books. Transillumination of this region in cases where this muscle was replaced by fascia, showed that the fascial continuation contained aponeurotic fibres.

Though, in the majority of cases, the aponeurosis of the internal oblique passed

in front of the rectus sheath without fusing with it, in a few cases, it was found, that the aponeurosis fused early with that of the *M. transversus* and the combined structure formed the rectus sheath. In a few cases the internal oblique split into two lamina which enclose the rectus muscle as in the supra-umbilical region. Essentially, therefore, there was no difference in the relation of the aponeurosis to the rectus above and below the mid point between the umbilicus and symphysis.

### M. TRANSVERSUS ABDOMINIS

This muscle presented considerable variations. In a large number, the muscular fibres extended down to the inguinal ligament and medially as far as the rectus muscle. Generally speaking it was less muscular than the internal oblique muscle. Like the internal oblique, in those cases of attenuation, the muscle fascia and its aponeurosis could be traced to the ligament and often it blended with the fascia transversalis on its deep aspect. The aponeurosis divided at the lateral margin of the rectus muscle into three laminae. The middle lamina split again to form an internal sheath and the outer and inner most layers passed in front and behind to form a second sheath for the rectus abdominis (Fig. 1). The posterior layer was so thin that the aponeurotic fascicles were spread apart to form the so-called arcuate lines behind the rectus muscle. As many as four arcuate lines or semilunar folds of Douglas could be counted behind the rectus below the umbilicus. The number of such arcuate lines were not constant and were different on the two sides in the same subject.

In all cases the transversus muscle and its aponeurosis were pierced by the cord and a tubular prolongation was carried over the cord into the scrotum. The lower fibres of the muscle formed the distinct cremasteric muscle. Medial to the point of entry of the cord, the aponeurosis passed to the lateral margin of the rectus to form its sheath. In only 5 or 6 cases was there a formation of falx when seen through transillumination light. The tendinous fibres

were seen to run obliquely downwards in bundles behind the cord to reach the ilio-pectineal line. These are described in the text-book as the conjoint tendon, Hesselbach's ligament and other bands.

### M. CREMASTER

This muscle is either formed by the lowest fibres of M. internal oblique or by M. transversus. In either case the fibres are carried on into the scrotum as the muscle fascicles of the cremasteric fascia. It has no special tendon of insertion as described in books. It is just a few muscle fibres of the inner two muscles which are stretched and carried over into the scrotum when the cord evaginates these muscles in succession.

### FASCIA TRANSVERSALIS

This, in my view, is to be considered as the membranous layer of the extra-peritoneal fatty tissue just as the fascia of Scarpa is the membranous layer of the subcutaneous fat in this region. This is not the muscle fascia on the posterior aspect of the

transversus muscle as some authors believe. When the muscle is degenerated as it often is, the muscle fascia, the aponeurosis of the transversus muscle and the fascia transversalis appear to blend. With transilluminated light, in such cases, the fascia transversalis appears to have certain thickened parts, which have been variously described as Henle's band, Henle's ligament, Interfoveolar ligament of Hesselbach, Thompson's ligament and so on. These different structures are really due to the aponeurosis of the transversus abdominis. They come to greater prominence when the aponeurosis of the internal oblique muscle fuses early with that of the transversus muscle as described above.

The fascia transversalis is attached to the whole length of the inguinal ligament and passes on to the posterior wall as a continuous fascial lining. It is not carried into the thigh over the femoral vessels as the anterior layer of the femoral sheath. So, as described before, the abdominal cavity is a closed fascio-aponeurotic cavity, inside which, is the serous cavity of the perito-

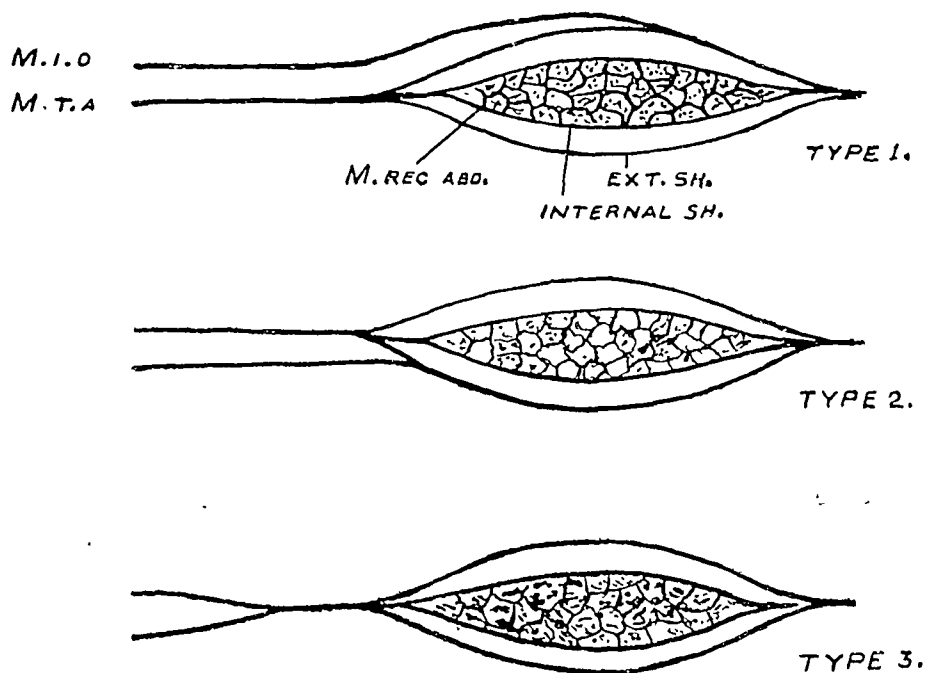


Fig. 3.  
Types of Rectus Sheath.



neum. Injection experiments clearly showed that the fascia transversalis never passes into the thigh and it directly becomes continuous with the fascia on the posterior wall.

Careful dissection of the inguinal region and a study of sagittal sections show that the inguinal ligament is a composite structure derived from fusion of the fascias of the abdominal muscles and fascia transversalis. There is only one compartment for the vessels and lymphatics behind it and through this the extra-peritoneal fatty space of the posterior abdominal wall in which the iliac vessels run, is carried into the femoral sheath (Fig. 5). Figure 4 shows the schematic drawing of a sagittal section across this region.

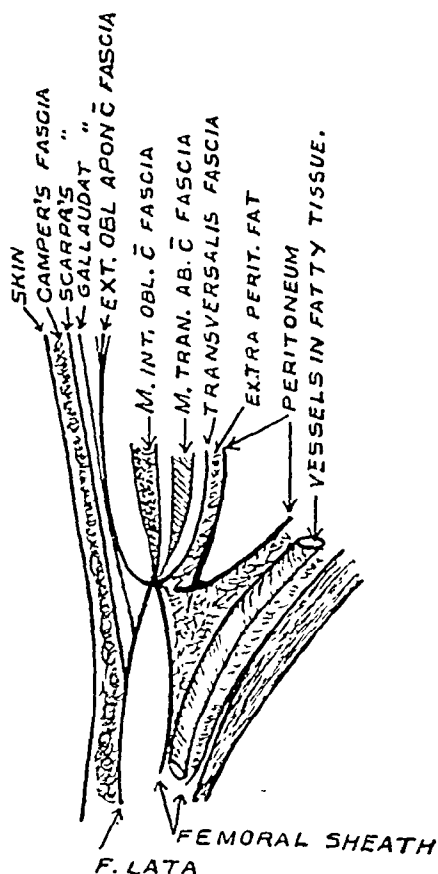


Fig. 4.

Vertical Section thro' Inguino-Femoral Region.

Certain structures like the Falk inguinalis, Hesselbach's ligament, and certain artefacts like the inguinal canal have acquired exaggerated importance, though they rarely exist. Some have been variously described as thickenings in the fascia transversalis, or extra attachments of inguinal ligament and so on. So they need in my view, further discussion,—though they have been mentioned before,—as to their nature and relations.

### 1. CONJOINT TENDON OR FALX INGUINALIS

It is conventionally described as 'the conjoint tendon of the internal oblique and transversus muscles and inserted into the crest and the pectineal line of the pubis behind the superficial ring'—GRAY (1940). From the above description of the muscles, it is seen that it is absent in a large number of cases; and when it exists, it is more fascial than tendinous. Out of 50 cases examined, in only 5 cases was there any thing like a falx. Even in these cases, there was early fusion of the aponeuroses of the two muscles but the lower part of this fused layer splits into two laminae. The anterior passed in front of the rectus muscle and the posterior passed behind and downward towards the pectineal line to form a 'conjoint tendon.' So the falx is rarely present. Either the lateral sickle-shaped margin of the rectus muscle, or the fused tendinous margin of the rectus and its sheath, or merely the down-turned aponeurotic fascicles of the two muscles are recognised by different authors as the falx. German authors call the lateral margin of the rectus and its sheath as the Falx. English books call the conjoint aponeurosis as the Falx.

### 2. HESSELBACH'S INTERFOVEOLAR LIGAMENT

Anson is of the opinion that it is a condensation of the connective tissue round the obliterated umbilical artery. From our study, we believe it to be an isolated bundle of aponeurotic fibres of *M. Transversus* which takes a curved course towards the inguinal ligament and appears as a distinct

reduced in this region are potential subjects for hernias. Secondly in such subjects the obliquity of the four openings is not so great. Probably these are close so that increased intra-abdominal pressure may abnormally push a loop of intestine through this weak part. The different levels of the openings, the distances between them and the differently directed muscle fibres of the muscles will normally act as shutter-like valves against any tendency for herniation. Also the muscle fibres around the openings may act as sphincters of these openings and relatively shift them and oppose them. In those people in whom the muscles are represented by their fasciae only, all these functions are lost and so the wall is greatly weakened. Any abnormal increase in the intra-abdominal pressure will then produce a hernia. Similarly in the inguinal triangle the hernias (direct) are scarce.

The internal oblique and the transversus muscles are muscular in most cases. It is only when they are fascial, that there is a tendency for hernias. The surgical implications of such a concept as the one discussed above will be dealt with in a separate paper.

### SUMMARY AND CONCLUSIONS

The following conclusions are arrived at from a study of the inguinal region in the local dissection material:—

1. The muscles—the internal oblique

mediate ones in the inner two muscles are not named.

5. An inguinal canal of conventional description is not present.

6. The Rectus abdominis has a complete double sheath from the Xiphisternum to symphysis, derived from the aponeurosis of transversus abdominis. The text-book description that, below the mid-point between symphysis and umbilicus, there is no posterior layer of the rectus sheath is not borne out in our cases. There is essentially no difference in the formation of the sheath in the two areas. The external and internal oblique do not really contribute in a large number of cases to the formation of the sheath.

7. The conjoint tendon, Henle's band, etc., are all thickened parts of the aponeurosis of the transversus abdominis. In cases where there is early fusion of the aponeurosis of the internal oblique and transversus, these may become more conspicuous. Normally they are conspicuous by their absence.

8. The femoral sheath is not formed by the fascia transversalis and the fascia iliaca as described in books. It has two strata. An inner sheath derived from the fatty tissue round the vessels and an outer layer derived from the connective tissue of the fascia transversalis is attached for the greater length of the femoral ligament.

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## RECURRENT DISLOCATIONS OF THE SHOULDER JOINT

by N. S. NARASIMHAN, F.R.C.S. (Eng.), Surgeon, Madras General Hospital, and Prof. of Operative Surgery, Madras Medical College.

Recurrent dislocation is fairly common in Madras. This paper is based upon a critical study of 99 cases treated during the seven years 1938—45. The prevailing ideas regarding the causation, incidence and pathological features are reviewed in the light of our experience.

The condition is mentioned by Hippocrates but the first accurate description was given by Dupuytren.

In a study of recurrent shoulder dislocations one should consider (1) anatomical mechanisms (2) pathology and morphology and (3) treatment (operative and non-operative) with an assessment of results.

In the study of the mechanism it is well to review some anatomical points. Magnusson and others dissected 21 shoulders to demonstrate this region and they were impressed by the size and strength of the ligaments in fresh post-mortem specimens. The coraco humeral ligament strengthens the superior aspect of the joint, and the inferior gleno-humeral ligament strengthens the lower and anterior part of the capsule which is situated above the quadrilateral space. The description of these ligaments as weak bands is an illusion produced in

the fixed anatomical specimens of the dissecting room. These dissections also demonstrated that the anterior capsule is always attached to the rim of the glenoid cavity and is never attached to the neck of the scapula. Radiographic examination after injection with lipiodol confirms this point.

The long head of the biceps is an important factor in the mechanism of the shoulder joint. At its attachment to the scapula, the tendon divides into three parts, viz., a large intermediate part which obtains direct attachment to the scapula and two smaller collateral parts which diverge from each other and blend with the labrum glenoidale. The long head of the biceps on account of its intraarticular position and its situation in the deep sulcus between the tubercles of the humerus is a very important factor in keeping the head of the bone in place and in steadying it in the various movements at the shoulder joint.

In the cadaver the head of the humerus could not be completely dislocated, even though all the muscles and the capsule were severed.

*Mechanism causing dislocation:* The shoulder is in maximum internal rotation.

when the arm is abducted until it is level with the shoulder, elbow flexed to  $90^\circ$  and the forearm pointed straight down. Further elevation of the elbow from this position is impossible due to locking of the greater tuberosity against the upper rim of the glenoid fossa of the scapula. Forcible elevation of the elbow above this point may result in an inferior dislocation or fracture of the greater tuberosity with a dislocation or a triple fracture involving greater tuberosity, head and shaft. What actually happens depends on the nature of the injury.

In an ordinary dislocation due to indirect violence, the head is forced through the lowest and weakest part of the capsule between the subscapularis muscle above and the long head of the triceps below. This has been verified in post-mortem examination. A typical sub-coracoid dislocation was first produced in the cadaver by Davies in 1899.

In a fall backwards, when the patient stretches out the arm to break the fall, dorsal extension of the arm is limited by the locking of the head of the humerus against the spine of the scapula at the point where it joins the acromion. Further forcible extension results in fracture of the shaft of humerus or an anterior dislocation, the head being pushed through the joint capsule dissecting the subscapularis from its attachment to the scapula.

This dislocation following dorsal trauma tends to recur because the movement of backward extension is frequently repeated in every day life. It has, however, been noted in our series that the interval between the two dislocations varied from a few days or weeks to as long as 15 years.

The greater tuberosity is pulled off in some dislocations. This occurs in severe injuries in patients who are rather muscular. This would suggest that one of the factors that prevent the head from going downwards and forwards is tension in the supra-spinatus and infra-spinatus muscles with some tension in the teres minor.

*Theories of recurrent dislocations:* The normal protective mechanism against dislocations are:

(a) Structural factors such as the anterior part of the limbus, the anterior rim of the glenoid fossa and the anterior attachment of the capsule.

(b) The physiological protection of the subscapularis. Changes such as thinning out and relaxation of the subscapularis have been described as occurring in recurrent dislocation but have not been seen in any of our operated cases.

*Bankhart's theory:* Bankhart's classical description of the two varieties of dislocation caused by direct and indirect violence is given in the Robert Jones Birthday volume.

Dislocation by *direct violence* is caused either by a fall on the back or front of the shoulder, or upon the point of the elbow while it is directed backwards or forwards. The head of the humerus in the former case is displaced not by leverage, but by a direct force which shears off the capsule from the fibrocartilaginous glenoid ligament and which frequently detaches the glenoid ligament from the bone. The detachment occurs practically over the whole of the anterior half of the glenoid rim. In a dislocation due to *indirect violence* the rent in the capsule heals rapidly and soundly but in that due to direct violence there is no tendency for the detached capsule to unite spontaneously with the fibrocartilage. The defect in the joint is therefore permanent and the head of the humerus is free to move forwards over the anterior rim of the glenoid cavity on the slightest provocation. This type of dislocation is liable to be associated with extensive laceration of the soft parts and with fractures of the neighbouring bones. These latter are due to the direct injury which produces the initial dislocation.

The essential feature in a recurrent dislocation is thus the detachment of the capsule from the fibrocartilaginous glenoid ligament. From this pathology, Bankhart concluded that the treatment of recurrent

dislocation is operative and consists in re-attaching the fibrous capsule to the glenoid ligament or fixing it to the bone at the anterior margin of the glenoid cavity.

Bankhart's views regarding the pathology have been more or less widely accepted but other views have been put forward at various times. The more important among them are:

1. Defects in the head of the humerus, either congenital or acquired after the first dislocation.

2. Defects in the glenoid cavity, e.g., shallowness of the congenital type or a fracture at the edge.

3. Rupture of the insertion of the external rotators of the humerus.

4. Avulsion of the greater or lesser tuberosity of the humerus, with or without rupture of the external rotator muscles. Tear of the supra spinatus and infra spinatus muscles in the original dislocation, may lead to loss of the supporting action. Duchenne has stated that recurrent dislocation cannot occur, unless the supra-spinatus tendon has been ruptured. We have, however, not seen it in any of our cases.

5. Detachment of the joint capsule from the anterior margin of the glenoid.

6. Capsular relaxation, either congenital or following tears which have not been given sufficient time to cicatrise or again due to repeated stretchings without actual tear. Jossel in one case injected the capsule with mercury and found its capacity to be three times as great as the normal.

7. Failure of neuro-muscular co-ordination (Codman).

Nearly everyone who has studied the subject has admitted that fracture of the glenoid rim especially the anterior margin with capsule laceration may favour habitual dislocation.

Hildebrand reported from Berlin 18 cases (3 bilateral) during the years 1913 to 1925. In these 21 shoulders, there was definite radiographic evidence of bony defect in the

head of the humerus in 15 instances. The defect may be a congenital one leading to habitual dislocation or it may be the result of the dislocation. There may be a complete or partial posterior notch—a wedge-shaped notch on the posterior aspect caused by the striking of the head against the glenoid margin when luxation occurs.

Paitrick and Didec (1930), Gregoire and Bazy described the X-ray technique for demonstrating the lesions of the head of the humerus and demonstrated deformities of the head in every instance. We have not been able to demonstrate the defect in our cases and an examination of 50 unselected humeri from the Anatomy Department of the Madras Medical College showed one humerus with a notch.

In recurrent dislocation there need not necessarily be a tear of the capsule to permit the head to leave the socket, and soon after reduction of the recurrent dislocation, the patient is free from pain because there is no inflammatory reaction.

Gallie believes that recurrent dislocation is caused by a defect in the inferior glenohumeral ligament and treats the condition by creating a new inferior glenohumeral ligament, which will prevent the head from gliding downwards and forwards when the appropriate leverage is applied.

*Theory of muscle imbalance.*—Paul B. Magnusson records an instance of twin brothers with recurrent bilateral dislocation of the shoulder. An elder brother had the same condition and the father and father's brother also had the same history. This incidence in several members of the same family suggested an anatomic weakness or muscle imbalance inherent in some individuals which permitted the condition to occur without severe trauma. Magnusson while admitting that the pathology of the tear of the glenoid labrum may be present in some cases does not believe the tearing of the anterior lip of the glenoid with a gap in the capsule at the point of tearing to be a cause. Magnusson does not repair the capsule because he thinks it is an exceedingly lax membrane and not worth repairing.

The postural tone of the muscles is important in preventing a dislocation. The stability of the shoulder joint depends on the muscles supporting it. In the shoulder joint, the ligaments are not as strong as the hip. A large rounded head articulates with the shallow glenoid which contacts only a small portion of the head. In these respects it differs from the hip where the depth of the acetabulum and the strength of the ligaments form the main support. In cases of muscular paralysis the head of the humerus drops away from the glenoid and lies well below it while with all the muscles paralysed, the strongest traction cannot pull the head of the femur out of the acetabulum. Can lack of muscle balance or muscle leverage to resist the downward and forward movement of the head be a contributing factor in the causation of recurrent dislocation?

The large incidence of recurrent dislocations in epileptics and the occurrence of dislocation during an epileptic seizure also suggest that muscle imbalance and muscle leverage may have something to do with the occurrence and recurrence of downward and forward displacement of the head.

In one out of nine operated cases Magnusson found that the tendon of the subscapularis was entirely free from the capsule instead of blending with it as is normal. When the arm was abducted and extended, the tendon slipped up between the head of the humerus and the glenoid and did not afford any support to the anterior capsule. This abnormality, however, was not found in the case of the two epileptics in the series.

There is no mention in the literature of a comparative study having been made of similar recurrent dislocations occurring in other joints. It would appear that there is no one common cause which can account for recurrent dislocations occurring in these joints.

In the case of the recurrent dislocation of the patella, it is the weakness of the quadri-

ceps, especially the vastus internus component, which is the important factor. Other factors such as imperfect development of the patella or of the external condyle, traumatic or pathological lesions of the internal ligament or genu valgum may be responsible for a few cases.

It is interesting to note that this condition shares with recurrent dislocation of the shoulder the reputation of having the greatest variety in the number and nature of operations recommended for its relief. Here also we see that operations on bones, on ligaments and on capsular structures have all been tried.

Several operations are used such as re-implantation of lateral half of ligamentum patellae into the medial side and attachment of the semi-membranosus tendon to the medial half of the ligamentum patellae.

Subluxation of the sterno-clavicular articulation, sometimes bilateral and recurrent dislocations of the temporo-mandibular joint seem to have this factor in common that the removal of the inter-articular cartilages cures the conditions.

The 99 recurrent anterior dislocation cases studied occurred in a total of 206 shoulder dislocations treated during the period under review and were distributed as follows:—

Age	Right		Left		Bilateral	Total
	Male	Female	Male	Female	Male	
5--10	1					1
11--20	14	1	2			17
21--30	27	—	20		2	49
31--40	13	1	3		2	19
41--50	5		3			8
51--60	3					3
61--70	1					1
71--80	1					1
Total ...	65	2	28		4	99

The primary dislocations (two posterior and the rest anterior) were distributed as follows:—

### AGE INCIDENCE

Age	Right		Left		Total
	Male	Female	Male	Female	
5-10	3	1	1	—	5
11-15	5	1	1	—	7
16-20	11	2	8	—	21
21-30	53	5	15	2	75
31-40	38	5	10	—	53
41-50	15	1	9	1	26
51-60	7	2	3	1	13
61-70	1	—	—	3	4
71-80	1	1	—	—	2
Total ...	134	18	47	7	206

It will be noticed that the incidence in the third decade is highest in both cases being 50% in the recurrent ones. Bankhart gives the highest incidence at the fourth decade. The youngest case was seen in a boy of 10 whose first dislocation occurred in hospital during a tetanic spasm. It was easily reduced but recurred during subsequent spasms. On discharge from the hospital, the shoulder was normal but the patient was not heard of again. Only five cases of recurrence were seen in patients above 50 years of age—an observation which raises the question whether the condition cures itself as age advances.

**Sex.**—Only two out of 99 recurrent cases were seen in females as against 25 out of 206 traumatic cases. Tavernier (1929) remarks "it is a striking fact that the proportion of recurrent dislocations among females is twice as great as the proportion of primary luxations."

**Nature of injury.**—It has been stated (Hobart and Bankhart) that the initial injury is always a violent one, the thrust being produced by the patient's own weight. In the cases under consideration, the primary dislocation was usually caused by comparatively minor trauma such as "fall on slippery ground" "while bathing" "during dandal exercises" and each successive recurrence was produced by even less trauma. The thrust produced by the patient's weight could hardly be called excessive, as the patients in this series were

comparatively small in stature. The fact that repeated recurrence was seen in a boy of 10 during tetanic spasms and the fact that 67% of recurrences were in the right shoulder, leads one to believe that lack of muscle control is a deciding factor in recurrence.

**Occurrence in epileptics.**—Seven patients were epileptics and one of them had bilateral recurrences. This number (approximately 70%) does not agree with the larger percentages given by other observers, "who comment on the great liability to recurrent dislocation manifested by epileptics and athletes." (Tavernier—1929.)

**Operative findings.**—Of the 99 cases of recurrent dislocation 16 (all males and only one epileptic) have been operated on and the opportunity was taken to study the pathology. On account of the want of a history of the typical dorsal type of injury in our recurrent cases, one was sceptical of the pathology as described by Bankhart. Particular attention was paid to the following points in an effort to study the pathology:—

1. Capsule attachment, capacity and tears.
2. Glenoid cavity and labrum.
3. Humeral head.
4. Muscles.

1. The capsule was never found to be lax and, in fact, was even tighter than in the cadaver. Our experience is that even cases of infantile paralysis in whom subluxation could be produced by allowing the arm to hang by the side, showed no laxity of the capsule, and no dislocation could be produced when the anaesthetised patient was on the table with the arm unsupported. This is in accordance with Henderson's statement that "these dislocations are difficult to produce by passive motion even in a habitual case under an anaesthetic." He thinks that voluntary muscle action is necessary. In the 12 Bankhart's cases, tears were seen in the anterior part of the capsule in eleven but in one case there was no proof that the head had left the capsule,

either attached to the glenoid or to the head. In two cases a gutter was found in the bone, exposing the channel through which the tendon traversed the head of the humerus, and containing nothing except a few strands of fibrous tissue. Keruwein in a study of tendon transplantation in dogs found that the tendon did not exist as such but degenerated into a few strands of fibrous tissue.

In one of our cases (Nicolas) there was recurrence four weeks after operation.

Bone transplants were used by Oudard (1924), Eden (1917) and Speed. The idea of an "anterior block" occurred to Speed when the structures were exposed during an operation for Radical Mastectomy and he treated his next case of Recurrent Dislocation by producing a bony bridge between the scapula and the humerus without opening the capsule.

*Eden's operations.*—Eden implanted a bone graft from the tibia on the bared anterior surface of the neck of the scapula overhanging the joint so as to prevent luxation.

Kellog Speed and Phemister use a bone peg taken from the tibia and driven into the antero-inferior border of the glenoid cavity leaving it projecting far enough to check luxation.

Oudard lengthened the coracoid process by dividing it across and interposing between the cut surfaces a graft from the tibia 4 c.m. long. Subsequently he split the coracoid and lengthened it by sliding down one half of the attachment of the Biceps and coraco-brachialis.

Ricordo and Fimiochietto use a coraco-glenoid bony bridge.

Dr. Sever of Boston says, "although plaiting or constricting operations on the capsule have been apparently successful in a number of cases—, yet the success was due not to any contraction of the capsule, but to the necessary interference with the muscles around the joint and in particular to the division and subsequent suture of the tendon of the subscapularis near its

insertion — an important part of Turner Thomas' operation of capsuloraphy. Other operators have divided part of the pectoralis major in order to enlarge the field of inspection."

Muscle sling operations such as Clairmont's came into vogue on the suggestion that most of the resistance of the shoulder against dislocation lay in the muscles and not in the ligaments and bone. Rich (1917) used the coraco-brachialis and biceps because he noticed that the capsule of the joint in these patients was not always lax and could not be plicated. He felt that the glenoid edge or the tendon of the supra spinatus, the subscapularis or the teres major were often torn and that any or all of these factors lead to recurrence.

Oudard (1924) stresses the importance of the subscapularis muscle in the retention of the humeral head. He sections and then overlaps the subscapularis tendon which thus shortened and reinforced, maintains its proper action. Tavernier while supporting Oudard's views, prefers the anterior bony block. According to Tavernier, no other procedure including Bankhart's operation and Henderson's tenoplasty is good.

The principle of tenosuspension is as follows. In anterior dislocation, the head of the humerus must go downward and forwards. If the downward extension can be prevented, the dislocation will not occur for there is sufficient muscular protection in the supero-anterior part of the joint to prevent the head from slipping out. Joseph used fascia lata and Henderson used peroneous longus tendon passed through holes bored in the head of the humerus and the clavicle and acromion process.

Young's operation consists in the lengthening of the tendons of the pectoralis major and latismus dorsi.

It is interesting to review the experiences of various writers with the different types of operations:

1. *Tenosuspension*: Henderson in 1926 reported 30 cases in 5 years (20 males and 10 females) including 4 epileptics. He seems to have given



up this operation in favour of others but has since 1935 returned to the original tenosuspension operation. Since then he has reported 27 cases with 3 recurrences. In his latest report in 1944, he gives 50 successful results in 55 operations (11 females and 40 males) 10 patients were under 21 years of age and 30 were between 20 and 40. The youngest of the series was 16 and the oldest was 50.

2. *Nicola* reported 132 cases with 8 recurrences. The Nicola operation has been performed in a number of instances by various surgeons; thus Korter did 3 cases with no recurrence, Willard 10 cases, Albee 33 with 1 recurrence, Speed 15 and so on. Codman however writes "all the cases recurred. I do not advise operation but advise development of the internal rotators. From what I hear the Nicola operation is not the last word."

3. *Muscle sling operations*. Clairmont's operation. Clairmont had 14 recurrences in 43 cases and Anderson reported 4 failures out of 8. Ryerson did 10 cases, presumably successful.

4. *Bony block*. Tavernier (1930) reported 37 cases (25 males and 12 females aged between 25 and 40) with no recurrence. In the original operation there was trouble with sinuses and sequestra. Speed (1930) reported 7 cases. No relapses are recorded even after 7 years; there was some limitation of extension and obstruction in some cases and in a few pain; this operation is almost unknown outside France.

5. *Capsulorrhaphy*: Thomas (1930) reported 12 successes in 18 cases. Henderson between 1926 and 1935 had 19 recurrences in 60 cases and gave up the operation. Trethowen draws attention to the difficulty of

plicating the capsule on account of the general distension and the present writer has always noticed that the capsule is already tight and cannot be plicated.

6. *Bankhart's operation*: Bankhart had no recurrence in his 27 cases and Watson Jones reported 30 successful operations. Moroney (1945) in a report of 27 cases has abandoned the Nicola operation following one early relapse and has since adopted the Bankhart procedure in his last 11 cases.

7. Heygroves while admitting the pathology as described by Bankhart pleads for a simple operation of suspension by means of a fascial sling through the quadrilateral space and tied above the coraco-acromio clavicular arch.

8. In the experience of the writers the first two cases were treated by the Nicola procedure and one recurred 4 weeks after operation. Of the 12 subsequent "Bankhart cases" none have so far recurred. The first case, a cook, done in August 1943 had had 20 dislocations previously but has had none since the day of operation.

Watson Jones states that any operation on the shoulder joint can prevent recurrence of dislocation so long as it is "sufficiently traumatic and sufficiently bloody." He contends that technique is unimportant so long as enough scar tissue is produced in front of the joint to limit backward extension and external rotation so that the humerus cannot face the position required for the head to slide over the injured glenoid margin. This statement is incorrect. The Bankhart procedure (very well described by Watson Jones himself in his "Fractures and joint injuries"—1944) is anything but a bloody operation and if it depended on trauma only for its efficiency, there would be a very large percentage of failures because the trauma is slight. All the patients operated on by me have been X-rayed a month after operation, and the

coracoid process has been found well united in good position in every case. The patients have been followed up and show no loss of backward extension or lateral rotation and this inspite of having the arm bound in internal rotation for three weeks. They are all employed as formerly (soldier, cook, electrician, peon, etc.) and in all the cases except three the right shoulder was the one affected.

### SUMMARY AND CONCLUSION

1. A study is made of 99 cases of Recurrent dislocations of the shoulder, with reference to age and sex incidence, body build, type of injury and family history.

2. The type of injury in recurrent cases is discussed with special reference to Bankhart's theory.

3. The incidence in epileptics is noted and a point made out of recurrences occurring during the chronic spasms of tetanus. pathology as noted in 12 operated cases is described.

The technical difficulties experienced in 12 cases in which the Bankhart procedure was adopted are noted and a discussion made of the comparative merits of various operations, with reference to after affects.

I am indebted to Major F. A. B. Shepard, O.B.E., I.M.S., Superintendent, Govt. General Hospital, for permission to publish the paper and to Dr. (Miss) J. Mathias, M.S., my Asst. Surgeon for all her help.

### APPENDIX OF CASES

1. Subramaniam, cook, aged 30, right, operated on in September 1943.

2. Convict, No. The Penitentiary, September 1943.

3. Shanmugham, aged 25 years, right, 16-12-44. Capsule torn anteriorly in two places.

4. Kandaswami, 20 years, left, 10-4-44.

5. Kulla Naicker, 27 years, right, 6-11-44.

6. Selvaraj (Tailor), 22 years, right, 3-1-45.

7. Sivaram, 23 years, left, 5-3-45.

8. Sampath, 24 years, left, 15-5-45.

9. Alagiriswami, 22 years, right, 29-6-45. Epileptic, seen recently all movements good.

10. Rozario, 23 years, right, 10-7-45. Glenoid labrum torn in two places. Margin repaired. Subscapularis thick. Cavity in front of neck of scapula.

11. Abdul Hamid, 21 years, right, 24-9-45.

12. Singaram, 25 years, right, 17-10-45.

All males, all between 20-30 years. 3 left and 9 right. All are under observation and are being followed up.

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## PRIMARY DIVERTICULITIS OF THE CAECUM

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Primary diverticulitis of the Caecum seems to be a very rare condition. Bennett-Jones has reported 3 cases and was able to find 17 cases in the literature. Edward Schnug (of Cincinnati) was able to record six of his own cases and 31 other cases. He has made a careful study of the subject. The condition may not be so rare as it appears to be because it is likely that cases which have perforated and formed abscesses in the right Iliac fossa are always regarded as the result of perforation of the appendix. Wagstaff in 1926 reported a case of acute primary Typhlitis. He found acute inflammation of the posterior part of the Caecum which had become almost gangrenous without any inflammation of the appendix. It is very probable that the condition was due to the perforation of a diverticulum.

Acute diverticulitis in this situation is difficult to distinguish from acute appendicitis and one should be prepared for this

possibility while opening the abdomen for the latter condition.

Usually in acute diverticulitis, the adjacent walls of the Caecum are also affected so that local excision may not be possible. "The technical difficulty together with the definite tendency of the lesion to drain into the bowel and subside suggests that surgical removal by radical procedure or local excision is definitely contra-indicated in most cases. Except in cases in which an abscess has developed and drainage is indicated, the abdomen should be closed without appendicectomy and without drainage and chemo-therapy should be used" (Edward Schnug). According to the majority of Surgeons, however, excision of the diverticulum with closure at the neck is the method of choice and when the inflammation extends to the Caecum, local excision of the Caecum surrounding the diverticulum is suggested.

In the case reported below, the wall of the Caecum surrounding the diverticulum was quite normal and so local excision was not difficult.

*Case Report.*—Dr. N. P. Male—age 37, was admitted for attacks of lower abdominal pain with vomiting and rise of temperature since 1942. The first attack was thought to be due to acute appendicitis. Through a McBurny incision, the appendix was removed. The appendix was said to have been slightly inflamed. Six months after the operation, he began to get similar attacks again. Each attack used to last for a fortnight and of late the attacks have been coming on more frequently. The Physicians whom he consulted subsequently attributed the attacks to adhesions and advised against operation.

*On examination.*—Caecum was found palpable and tender; no other abnormality; Heart and Lungs—normal; Urine—Sugar nil; Albumen, nil; no casts or cells.

*X-Ray.*—Plain skiagram showed no evidence of renal or gall stones.

*Barium meal pictures.*—Normal stomach with large duodenal bulb. Caecum shows restricted mobility and there is some delay in the terminal ileum, perhaps due to adhesions and tendency for spasms to supervene producing delay in the passage of the meal.

In view of the persistence of these attacks which suggested the existence of some focus of recurring inflammation it was decided to explore the abdomen.

*Operation notes by Dr. C. P. V. Menon.*—Spinal anaesthesia—Right paramedian inci-

sion. The Omentum was adherent in the Right Iliac fossa. This was released. There were some adhesions near the termination of the Ileum. These were also divided. In the Caecum, about 2" distal to the Ileocaecal valve, was a diverticulum, the size of a marble containing a hard concretion. There was also a Meckel's diverticulum in the usual situation. No other pathological lesion was found. The two diverticula were excised and the abdomen closed in layers. The patient had an uneventful recovery and was discharged from the Clinic in a fortnight.

It is highly probable that the 1st attack was due to acute diverticulitis and the condition might have been missed due to the inadequate exposure of the McBurny incision.

### SUMMARY

A case of Primary diverticulitis of the Caecum which was mistaken for acute appendicitis and treated as such is reported.

It is suggested that the condition was missed at the first operation on account of the inadequate exposure obtained with the McBurny approach.

I wish to thank Lt.-Col. K. G. Pandalai and Dr. C. P. V. Menon for permitting me to report this case.

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# HYDRONEPHROSIS IN ONE HALF OF A HORSE-SHOE KIDNEY

by C. P. V. MENON, General Hospital, Madras.

Pathological conditions affecting fused Kidneys are of considerable importance to the Clinician apart altogether from their embryological interest as the non-recognition of such an anomaly may result in the inadvertent removal of the whole fused renal mass with a fatal result. A few instances of such a major calamity have been recorded in the literature but many more must have gone unrecorded. It has been generally held that the condition, in itself, does not call for Surgical treatment. Foly and Wilmer (1938) have, however, indicated the possibility of a Surgical attack on fused kidneys of the unilateral and the horse shoe type for relief of pain and the arrest of hydronephrotic changes. Donohue (1932) reported six cases of operative division of the Horse-shoe Kidney and previous to that there seems to have been only about a dozen cases reported in the literature. Foly had since employed "symphysiotomy with nephropexy" in 5 cases of Horse-shoe Kidney and one case of Unilateral fused kidney. From a collective review and from their own experience with 5 cases of Horse-shoe Kidney and one of unilateral fused kidney, Foly and Wilmer express their belief "that the pelvic dilatation occurring with these anomalies and the pain accompanying them are capable of correction and relief by a well-conceived Surgical procedure which is feasible unless prevented by the vascular arrangement or the form or extent of fusion."

The Horse-shoe Kidney while being subject to all the pathological conditions affecting normal Kidneys, is peculiarly liable to hydronephrotic changes—in fact a mild degree of dilatation of the pelvis is always present. This is due to the abnormal position of the pelvis—ventrally situated with one or more Calyces directed mesially—and the abnormalities of vascular arrangement. The mesial direction of the calyces and the alteration of the axes of the Kidneys which

point downwards and medially instead of downwards and laterally is the result of interference with the normal ascent and rotation of the Kidneys and it is on these abnormalities that the pyelographic recognition of the condition depends. In the case under report, dilatation of the pelvis had progressed considerably more on one side and gone on to the point of complete destruction of renal function. The patient presented himself for what was to all intents and purposes a unilateral hydronephrosis with, however, a few unusual features—the cystic tumour being situated rather too low and too much to the front. This abnormal situation and the pyelographic appearances on the other side enabled a pre-operative diagnosis of the abnormality to be made and prevented the inadvertent removal of the whole renal mass—a calamity which could conceivably have occurred otherwise.

*Case Report.*—Patient, Adikesavalu, Hindu, male, aged 18 years, occupation—coolly, was admitted into the General Hospital, Madras, on 3-6-'43, for a swelling of the lower abdomen. He had noticed a small swelling ever since he can remember and it has been gradually increasing in size; for the last 10 days it has become painful. He did not complain of any other symptom; micturition has been normal. On examination, the patient, a well-nourished boy of 18 years presented a globular swelling in the lower abdomen about 10" in diameter occupying the hypogastric, umbilical and left lumbar regions. The swelling was firm and smooth with well-defined outline. It was slightly movable from side to side and upwards and downwards, but did not move with respiration. It was dull on percussion throughout there being no band of resonance in front and a fluid thrill could be elicited. A plain Roentgenogram showed a diffuse opacity in that region and no foreign shadows. A Barium enema (Fig. 1) showed the des-



Fig. 1

Ba enema.—Shows the displacement of the colon and indicates the size of the Cystic swelling.



Fig. 2.

Excretion Pyelogram.—Shows complete absence of excretion on the left side and the reversed position of the pelvis on the right side. Calyces directed medially and the pelvis laterally situated.



Fig 3.

Photographs of specimen.—Shows the posterior view in which the lobulated, elongated outline of the left limit of the horse-shoe can be made out. The large dilated pelvis is in front with the probe in the ureter.

cending and Iliac colon pushed over to well across the middle line. This accounted for the absence of a band of resonance in front. The urine showed nothing abnormal except a few pus cells, but no organisms were grown in culture. I. V. Pyelogram



Fig. 1.

Excretion Pyelogram after operation.—The slightly increased dilatation as compared with Fig. 2 is well seen.

(Fig. 2) showed no excretion on the left side. On the right side, the pelvis was lying laterally with calyces directed medially. There was early hydronephrosis. The blood Urea was normal. Cystoscopy was done on 7-6-'43 and a catheter passed into the right ureter. - Urine was drawn from this and showed on analysis a percentage of 1.09% of urea. On the left side the catheter could be passed for about half an inch at which point it seemed to be arrested. A retrograde pyelogram was not done on the right side as one did not like to take any liberties with the only functioning Kidney.

From the X-Ray appearances, a diagnosis of a horse-shoe kidney was more or less confidently made. Four days later, he was operated on under General anaesthesia. The left Kidney was exposed by a loin incision. The tumour was found to be a large hydronephrosis. To facilitate removal, it was tapped, 80 oz. of brownish fluid being drained. On dissecting up the sac, its connection with the other side was made out, and looked like kidney tissue about an inch broad. This was crushed divided and over sewn. The ureter was narrow and

was divided. The vascular pedicle, situated rather lower down than usual, was clamped and divided close to the Kidney. The fluid from the hydronephrotic sac contained 4.1 mgms. % of urea. His convalescence gave no anxiety.

An I. V. Pyelogram (Fig. 4) taken a month after operation showed a little more dilatation than in the previous picture. A nephropexy on the line suggested by Foley might have prevented this, but the author was at the time unaware of this procedure. The patient has not reported since and is presumably well.

## SUMMARY

A case of Hydronephrosis in one half of a Horse-shoe Kidney is reported and a reference to available literature made.

A pre-operative diagnosis could be made from pyelographic appearances and thus inadvertent removal of the whole mass was avoided.

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## FIRST RIB SYNDROME

by DR. S. C. MISRA, M.B.B.S., L.R.C.P., F.R.C.S.,  
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AND

DR. M. L. SHARMA, M.Sc., M.B.B.S.,  
*Demonstrator of Surgery, Medical College, Agra.*

## INTRODUCTION

The possible occurrence of ribs in parts other than the thoracic region is explained by the existence of the myosepta and other skeletogenous structures in all regions. Primitively there is a pair of ribs for every vertebra from the axis to the sacrum. Some fishes have even two pairs. Ancestors of modern man had more than 12 pairs. During the course of evolution ribs have been reduced in number from both sides (cervical as well as lumbar). In the higher vertebrates they are confined to the thoracic region only. That reduction is going on in the number of pairs of ribs is borne by the not infrequent occurrence of anomalies at the cervical and lumbar ends. Persistent cervical ribs are more frequently incomplete and fail of direct sternal attachment. The first pair of thoracic ribs may sometimes be incomplete (Pilling, quoted by Walters, 1930). Bifurcation of ribs sometimes occurs at their vertebral ends (Arey, 1943). A

cervical rib may fuse with the costal elements of the first dorsal rib and this gives rise to a bicipital rib (Wood Jones).

The first dorsal rib has been seen to end like an ordinary second rib. Very rarely the first true thoracic rib is incomplete (Huber, 1930) being continued in ligament to the sternum, joining the costal process of the second or ending free. A bicipital rib may occur also by fusion of the first thoracic with the second beyond the tubercles. Rudimentary first rib is often mistaken for cervical rib (Frazer, 1940). The first rib occasionally shows reduction in extent, being short and slender, its costal cartilage being likewise reduced and replaced in part by fibrous tissue connected with the second costal cartilage. Ossification of the first cartilage affecting the surface and resulting in a bony enveloping mantle is frequently encountered (Huber, 1930).

The vertebral end of the first thoracic rib may be joined by a cervical rib, or by the



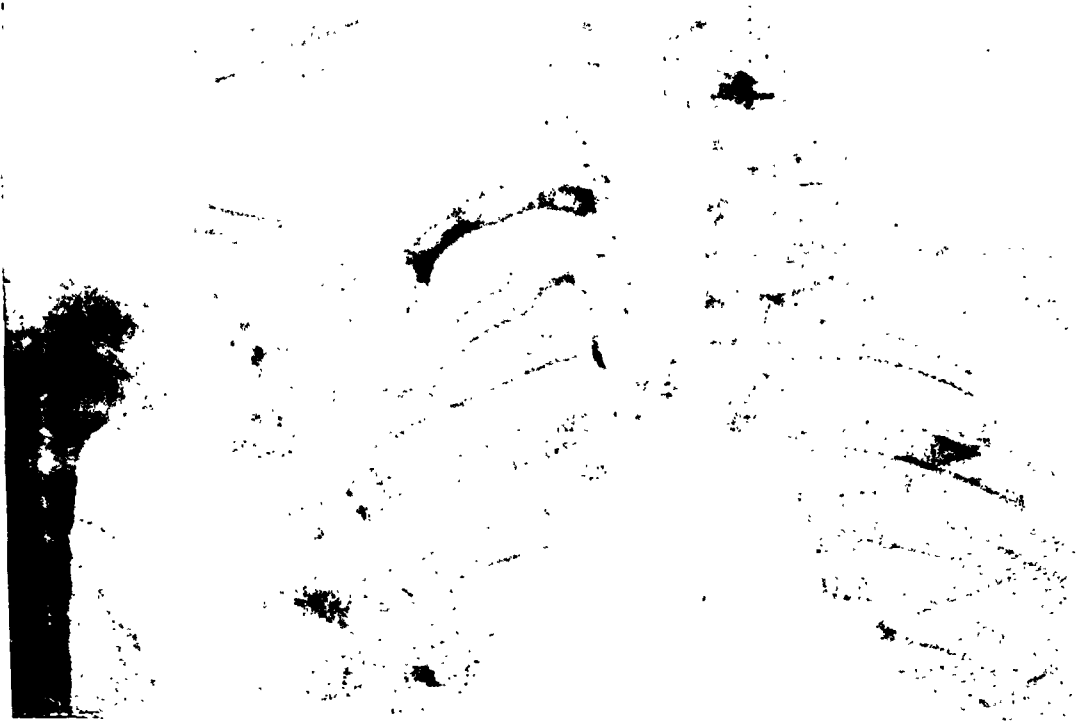


Fig. 1.

Preoperative X-ray showing the deformed first rib with false joint and its fusion with the second





vertebral end of the second thoracic rib, in which cases a bicipital rib occurs. The anterior extremity of the rib may be bifurcated. The adjacent ribs may be connected by small plates of bone (Frazer, 1937).

The comparative aspects of the first dorsal rib are, too, not less interesting. Confining to the mammals only, in *Notoryctes* (which has fourteen pairs in all) the first rib is very stout and is abruptly bent on itself to join the sternum. It has no distinct sternal portion. In the *Armadillos* it is remarkably broad and flat and is not divisible into vertebral and sternal portions. In the *Cetacea* it is the only rib attached to the sternum.

Principal factors involved in the production of anomalies of the skeletal system are faulty histogenesis, developmental arrest and over development.

### HISTORICAL

As far back as the 19th century Leboucq (quoted by Walters, 1930) mentioned in words as well as in drawing about the occurrence of abnormal ribs on the 7th cervical vertebra and the reduction of the first rib. Theodore Thompson (1908) pointed out that when a bony prominence can be felt with ease the Brachial plexus is free from pressure of the abnormal rib. A few years later Sir Percy Sargent observed that the symptoms might be present on the side with smaller abnormal rib and not on the side with a bigger rib. One of the most important contributions to our knowledge of these cases came from F. Wood Jones who in 1912 pointed out that anomalies in arrangement of limb plexuses are primary and not secondary to anomalies in disposition of ribs and vertebral elements. That symptoms might be produced by the abnormal first dorsal rib was described by L. Rogers (1937), W. Mck. Craig and P. A. Knepper (1937) reported six cases from the Mayo clinic.

### CASE REPORT

Har Bhagwan, a Hindu male student, aged 11 years, from Dholpur was admitted to the surgical wards on 4-8-'45. He com-

plained of swelling over the right collar bone, pain at the above site as well as in the axilla and involuntary movements of the fingers of the left hand when the patient attempted to write with his right hand. He also complained of slight weakness of the right arm. The duration of trouble was four years. He did not give any history of pain down the arm.

On examination there was a swelling just above the lateral third of the right clavicle  $1\frac{1}{2}'' \times 2''$  with diffuse and irregular margins. On palpation it was bony hard, the hardness continuing with the vertebral column behind. It was tender. The pulsations of the subclavian artery were visible.

*Examination of the right upper limb.*—There was no wasting of muscles, no drooping of the shoulder, no colour changes in the hands, fingers or nails (tested both in dependent position as well as by raising the arm.) On palpation there was no hyperaesthesia, anaesthesia or paraesthesia. Warmth was normal. Radial pulse on right side was 90 per minute and on left side 86 per minute. There was no difference in the rate, rhythm, volume, or tension of the pulse in the raised and hanging down positions of the limb. The grip of the hand was slightly weaker on the affected side.

*X-ray report.*—(Preoperative).

*Lateral view.*—First rib on the right side deformed. First and second ribs fused anteriorly. First rib has a false joint.

*Post-operative.*—A.P.

Read with the previous report. Part of the 1st rib resected. Fusion of the anterior ends of the 1st and 2nd ribs confirmed.

The X-ray plates further show rudimentary cervical rib on the right side.

*Operation notes.*—The patient was operated on under Chloroform anaesthesia by Prof. S. C. Misra, F.R.C.S. An incision 6'' long was made along the crease of the neck, parallel to and 1'' above the clavicle. The deep fascia was divided till the borders of the Trapezius and the Sternomastoid were exposed. The Sternomastoid was partially divided. The lateral margin of the Scaleneus anterior was then identified and it was par-

tially divided. The phrenic nerve was pushed medially. The lateral cord of the Brachial Plexus was seen emerging from under the lateral margin of the Scalenus Anterior. The subclavian artery was also identified.

The transverse scapular vessels which obstructed the way were clamped and ligatured. It was now seen that the artery and the cord were passing in between the knob of the eminence of the first rib and the clavicle. It was also felt that the Scalenus Anterior was contributing its share in narrowing the space.

Anterior Scaleneotomy was performed and the rib was now plainly felt and seen. The periosteum over it was incised. The joint (costo-chondral junction) was seen lying behind the structures. The first rib was carefully cut at the cartilaginous point and as much of the rib as possible was removed. The deep fascia was then apposed and the skin sutured.

*Post-operative care.*—The patient was kept in recumbent position. Breathing exercises and exercise of the right upper limb were given two hourly. He was given exercises for the neck muscles. He was asked to practise writing with his right hand and it was observed that the involuntary movements of the left hand had disappeared. He made an uneventful recovery.

#### IMPORTANT POINTS IN THE CASE

The case is peculiar in the following respects:—

1. The occurrence of an abnormal first rib producing symptoms at such an early age. The position of this abnormal rib as compared to the corresponding rib on the opposite side. The peculiar synchondrosis in the rib.
2. Marked prominence of the cartilaginous joint of the two component parts.
3. The occurrence of involuntary movements of the fingers in the left hand.
4. The first rib is fused with the second at its anterior end.

#### ACKNOWLEDGEMENT

We are most grateful to Major General H. C. Buckley, Superintendent, Thomason Hospital, for his kind permission to report this case.

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## CONGENITAL CYST BRAIN

by DR. D. GOVINDA REDDY, M.D. and DR. C. MOHAN RANGAM, M.D.,

*Department of Pathology, Medical College, Madras.*

The patient a male of 56 years was admitted moribund and comatose with dilated pupils, rapid pulse and absent plantar reflexes. The urine showed no sugar and no acetone but a trace of albumen.

During the post-mortem examination, nothing grossly abnormal was found in any of the viscera. The surface vessels of the brain were congested and Parieto-occipital region felt cystic; a medial sagittal section revealed an orange sized cyst in the left parieto-occipital region with an opaque wall and clear contents.

The cyst during its growth appeared to have filled the lateral ventricle and distended it stimulating a unilateral internal hydrocephalus. Scrapings from the wall of the cyst did not show any hooklets. Dissection after fixation showed the pedicle of the cyst adherent to the choroid plexus. Histologically the wall of the cyst was formed by consecutive strands of fibrous tissue lined by flattened endothelium. It is possible that the cyst was congenital having its origin from the choroid, since there was no neoplasia. Congenital cysts of the choroid reaching this dimension are very rare.



Fig. 1.  
Cyst of the brain in the left  
parieto-occipital region.

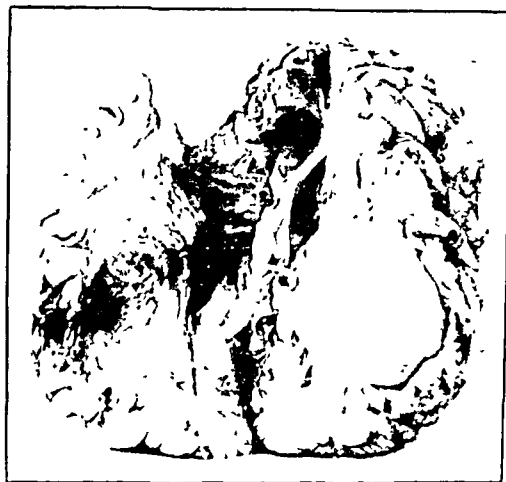


Fig. 2.  
The cyst is found filling the left ventricle  
with thinning of the cortex.

## ADENOMA OF PITUITARY

by DR. D. GOVINDA REDDY, M.D. and DR. C. MOHAN RANGAM, M.D.,

*Department of Pathology, Medical College, Madras.*

The patient was a female of 25 years admitted for headache and blindness of 2½ years duration and progressive loss of vision. The pupils were regular, dilated and reacting to light and the patient was mentally deficient. A decompression operation was done when the brain was seen to be oedematous and to pulsate feebly. During the autopsy examination no evidence of pituitary dysfunction or hyperfunction could be gathered. There were a few adhesions in the left pleural cavity and both lungs showed basal congestion. On removing the skull cap, the brain matter was seen forcing itself out through the dura in the

fronto temporal region. The brain was oedematous and the C.S.F. increased in amount. The clinoid processes had to be chipped to expose a small egg sized hard nodular tumour in the region of the optic chiasma. A median sagittal section of the brain confirmed that the tumour had its origin in the Pituitary and was reddish brown from haemorrhage. Histologically the tumour was a chromophobe adenoma of Pituitary. Special methods of staining such as Mann's and modified Mallory's Aniline blue technique failed to show either acidophilic or basophilic granules.



Fig. 1.  
Median sagittal section of the brain showing  
adenoma of Pituitary gland.



Fig. 2.  
Photomicrograph showing chromophobe  
adenoma of Pituitary.

# A CASE OF CONGENITAL UNILATERAL HYDRONEPHROTIC ECTOPIC KIDNEY WITH CALCULI

by DR. S. P. SRIVASTAVA, M.S., F.R.C.S. (Eng.), Medical College, Agra.

"R"—A patient aged 20, Hindu, Male, vegetarian was admitted into Thomason Hospital, Agra, on 3-8-'45, with the following complaints:—

Pain in the left Iliac fossa—1 year.

Past History.—Nothing of clinical importance.

Present History.—Patient stated that he had been having a mild pain in the left Iliac fossa for the last one year. The pain was not colicky in nature and did not have a tendency to radiate in any direction. He never complained of any pain or difficulty in micturition.

Examination—Local.—On palpating the left Iliac Fossa, two stony hard tender swellings each about  $\frac{1}{2}$ " by  $\frac{1}{2}$ " were found. They were fixed to the surrounding structures and were Intra-abdominal. The hard Lumps appeared to be calcified glands.

Investigation.—

(a) Urine examination—Normal with the exception of few pus cells only.

(b) Blood Urea—61 mgms. per cent.

(c) Plain X-ray abdomen—No radio-opaque shadow in the kidney or ureteric regions. Two rounded—radio-opaque shadows in the region of upper part of left sacro-Iliac joint.

(d) Excretion Pyelography after Intravenous injection of Uropac—Left kidney Ectopic and shows evidence of hydronephrosis and presence of calculi. No excretion by Right Kidney. The shadow in the left kidney too was faint.

The left kidney was situated in the left Iliac fossa.

(e) Total and differential W. B. C. count—Total white cells—8,450 cmm.

Poly—64%.

Lymphocytes—32%.

Monocyte—4%.

Treatment.—Operation—

Anaesthesia—Spinal percain 1 : 1500—  
14 c.c.

Pre-medication—Luminal 1 gr.  
Ephedrine  $\frac{1}{2}$  gr. by  
intramuscular injection.

A left Lumbo-Inguinal Incision about 8" long was made and the muscles were cut till the kidney was exposed in the left Iliac region. The upper pole of the kidney was palpated and found to be free. On palpating the kidney pelvis, a stone was felt and this was removed by opening the pelvis from the anterior side as the surface was devoid of blood vessels. Another stone was found on the medial side and was also removed. The ureter was slightly bigger than normal and was patent. No evidence of horse-shoe kidney could be found. The nick in the Pelvis was closed by plain cat gut. Perfect haemostasis was insured—Sulphanilamide powder was put in the wound and skin closed after leaving a drainage tube.

Patient was given Intravenous saline 700 c.c. with 5% glucose by drip method during the period of operation.

—He was given two Cibazol tablets three times a day.

—I. V. Glucose 25% 100 c.c. was given morning and evening for two days.

—I. V. Saline 150 c.c.

—Inj. Solusepticine 10 c.c. 10% Intramuscularly for two days morning and evening.

Progress Report.—Stitches were removed on ninth day. Healing was primary. Pt. did not develop any Post-operative complication during the course of treatment and was discharged on 13-9-45 completely cured.

## DISCUSSION

This case is interesting from several points of view. The history of the case never gave any indication of the presence of any calculus in the Urinary Tract. Urinary symptoms were conspicuous by their absence. The stony hard lumps being stones in the Pelvis could be felt per abdo-



Fig. 1.

Plain X-ray showing dumbbell shaped radio-opaque shadow over the left sacro-iliac joint.

men, because the patient had thin abdominal walls and the pelvis of the kidney was situated anteriorly to the kidney swelling. The latter was not at all palpable. The patient had a high blood urea and the shadow of the dye in the pyelogram was faint showing degeneration of the only existing kidney. This made the operation imperative. The stones could be removed without difficulty from the pelvis by incising its anterior wall which had no blood vessels in front of it, the blood supply of the kidney being situated posterior to the Pelvis and arising from the left Iliac vessels in such cases. The lower pole of the kidney could not be defined properly, as it extended into the Pelvic cavity.

The X-ray showed the left ureter bigger than the normal size and complete absence

of the right ureter. At operation one of the stones was removed from a lower calyx which was directed medially and backward showing either the extension of the kidney mass of the lower pole towards the middle line in the pelvic cavity or abnormal position of the calyx in the left ectopic kidney.

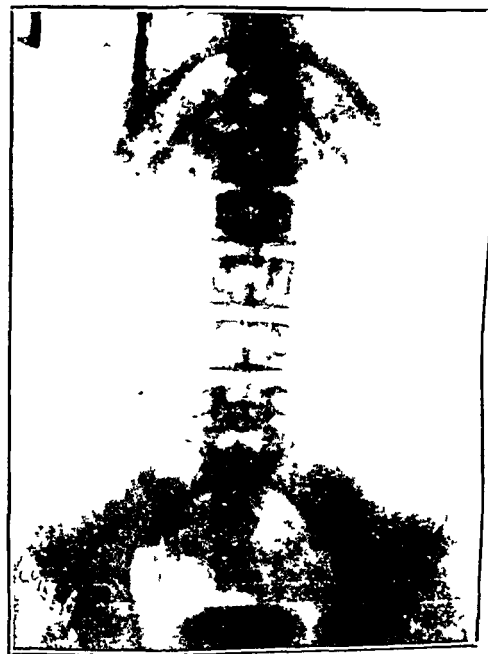


Fig. 2.

Pyelogram after injection of uropac showing faint dilated shadow of the pelvis of left ectopic kidney.

The single left ureteral shadow and the site of kidney indicated that it was either a case of single Left ectopic kidney with calculi and slight hydronephrosis, or unilateral fusion of left ectopic kidney with both ureters opening on the left side.

Cystoscopy and injection of Indigo-carmin could have cleared the presence of one or two ureteral openings but it could not be done, but usually even if there are two ureters on one side, the opening in the bladder is single.

In my opinion the case appeared to be one of left ectopic kidney with abnormal situation of calyces and stone formation as is probable in such cases. It would be interesting to watch the fall in blood urea after some time as the kidney function improves.



# PSYCHO-SURGERY\*

by DR. B. N. BALAKRISHNA RAO

Mr. President, Ladies and Gentlemen,

I thank you for the opportunity given to me to place before you a subject which perhaps is an innovation in surgery—a method of treatment of mental disorders by surgical means. Historically speaking, it certainly is not new. The operative treatment of "lunacy" as then known and understood was known and practised from prehistoric times. It is worthy of remark that in the glimmerings of surgery, operations on the skull and brain were about the earliest. Mummies unearthed in Egypt and Peru show that the operation of opening the skull i.e., trepanning, was not unknown to the people at the time. With sharpened flints and teeth of fish, they made a hole in the skull. Among hoary superstitions the one concerning itself with the belief in the "possession" of the human body and the mind by demons is perhaps the most interesting. For the relief from this "possession" the aid of the witch doctor, the equivalent of the modern surgeon, was not infrequently invoked and many prehistoric skulls testify to the successful performance of this formidable operation.

Thus the surgery of mental diseases has been in reality one of the oldest branches of surgery, if not the forerunner of other surgical procedures. Reasons for such a procedure might be considered incorrect from modern knowledge of the physiology of the brain; but nevertheless the aid of surgery certainly was sought for the relief if not cure of mental diseases.

The branch of neuro-surgery which I have in mind to-day is what is generally termed Psycho-surgery. Psycho-surgery consists in the surgical operation on the anatomically intact brain for the purpose of relieving abnormal mental symptoms. It

was first devised and named by Egaz Moniz, the distinguished Portuguese neurologist, essayist and diplomat, following the Third International Neurological Congress in 1935, at which time a remarkable symposium was offered on the function of the frontal lobes. Moniz published his monograph in 1936 detailing the results of his first twenty operations in mental patients.

Moniz had observed that individuals with organic lesions of the frontal regions of the brain showed varying degrees of emotional instability, lessened inhibition with the development of what might loosely be termed as an easy-going personality. He, therefore entertained the hypothesis that doubt, indecision, worry and anxiety were mediated through arcs in the frontal regions, and argued that if these pathways could be destroyed, the individual could then exist on a much more comfortable level. It might be remarked in passing that this is too naive a hypothesis, but that need not deter us from admiring his work.

Hebb and Penfield have investigated human behaviour after extensive bilateral removal of the frontal lobes. A case of traumatic injury had destroyed somewhat less than one-third of each frontal lobe, and left a scarred zone in each hemisphere, giving rise to continuing abnormal electrical potentials, and to recurring epileptic seizures. Although after operation a third, and possibly more of the total volume of each of the frontal lobe was lacking, there was a striking post-operative improvement in personality and intellectual capacity, with the same medication as before the operation. No clinical or psychometric evidence of deterioration was detected. It was concluded that removal of a third of both frontal lobes uncomplicated by pathological change in the rest of the brain need have no grossly deteriorating effect.

Moniz (1936) in discussing the theory which led him to propose prefrontal leuco-

\* A lecture delivered at the seventh annual meeting of the Association of Surgeons of India December 1945.



we have seldom been able to see it, so that, we have relied on the surface measurements alone.

The size of the trephine opening is variable, but our preference is to make a hole in the skull  $\frac{3}{4}$  inch in diameter with a burr using a Hudson or a Carr's brace. An avascular area of the dura is lifted with a dural hook and incised with a cataract knife, and the width of the brain measured with callipers. After the dural incision, a variable amount of cerebro-spinal fluid escapes, in some cases as much as three ounces.

The diameter of the brain is measured in order to estimate the thickness of the white matter. In a series of measurements it was found that the maximum width of the brain in our series was  $11\frac{1}{2}$  cms. and the minimum  $9\frac{1}{2}$  cms. with an average of  $10\frac{3}{4}$  cms. The thickness of the white matter was estimated after a series of measurements of the thickness of the white matter to the grey matter at the level of leucotomy was made in cadavers. It was found that the width of the white matter was equal to the sum total of the thickness of the grey matter. Therefore the instrument can be introduced through  $\frac{3}{4}$  of the width of the brain without damaging the grey matter on the mesial surface of the frontal lobe.

An avascular area of the dura is lifted with a hook and incised with a cataract knife, opening the subarachnoid space. The amount of cerebrospinal fluid escaping is variable, and sometimes as much as three ounces on each side, which is of no consequence. The white matter is now cut by introducing the leucotome to the desired depth in the direction of the opposite trephine opening.

Different varieties of leucotomes have been used. Moniz in his original method used a steel loop working like a nasal polyposus snare. Freeman and Watts used an ordinary blunt Killian's nasal elevator after making sure by means of spinal needle that the track of the elevator would not intersect the anterior horn of the lateral ventricles. McGregor and Crumbie intro-

duced a leucotome which cuts cores of  $2\frac{1}{2}$  cms. diameter by a knee action screw. In our first twenty-five cases the Killian's nasal elevator was used, and later when the McGregor and Crumbie leucotome was received, it was used in a few cases. After using the McGregor and Crumbie leucotome in a few cases, in one case when the instrument was inside the brain, the mounting of the rotary blade slipped, and the instrument was withdrawn with the greatest difficulty after much damage to the brain. After this accident, a simplified leucotome was devised with the assistance of Dr. Chandrasekharan which combines the simplicity of the Killian's elevator and the advantage of the McGregor and Crumbie leucotome. This instrument was made *locally in silver and has been in use with us* and is eminently satisfactory.

The white matter is severed by moving the elevator through an arc of 60 degrees in a plane parallel to the coronal suture. The plane through which the white matter has now been cut is known as "the plane of critical section," as, cutting the white matter in front of this plane will not produce much improvement, while section posterior to this plane produces certain undesirable consequences, and in some cases dangerous to life. In this plane the white matter constituting the fronto-thalamic radiation is in a compact mass just anterior to the anterior horn of the lateral ventricle. This bundle of white matter appears to be the most important of the fibres to be sectioned. The instrument is withdrawn and the amount of haemorrhage from the brain is usually very small and is controlled by warm saline irrigation. The dura is not sutured, and the wound is closed in layers without drainage. A similar procedure is adopted on the opposite side.

While the white matter is being severed certain changes are observed in the patient. American observers operating under local anaesthesia have observed a sudden release of psychic tension on completion of section of the white matter, which the patient can describe well. We have no experience of

this, as all our cases have been operated on under chloroform narcosis. Certain circulatory and respiratory changes have been observed when the white matter is cut. The respiration which is regular suddenly becomes irregular both in rhythm and depth. Short gasps are followed by long sighing type of breathing. Occasionally the respiration becomes shallow and a temporary period of apnoea has supervened. This is only for a short duration and respiration rapidly regains its rhythm and regularity. Sectioning of the opposite frontal white matter produces similar but less marked disturbances.

Simultaneously with the respiratory change, the pulse becomes irregular and sometimes thready and imperceptible. In no case in our series has the heart stopped, and it rapidly recovers after the completion of the section of white matter. It suggests to us that these changes are the result of the sudden interruption of some controlling influence of the prefrontal cortex on the respiratory centre, throwing the latter suddenly 'out of gear'; the cardiovascular irregularity being secondary to the respiratory disturbance.

No special post-operative care is necessary. The patient is propped in bed after recovery from anaesthesia. If there is restlessness or severe headache which is sometimes complained of, morphia is given, and repeated if necessary. The post-operative period in our series of cases has been singularly free from symptoms. Retention of urine was seldom seen, and incontinence of urine was present in three cases lasting from one to six days. All recovered within a week. Irregular rise of temperature was noted in a few cases lasting up to a week, for which no definite cause could be found.

One extremely striking feature during the post-operative period was the enormous appetite. A few complained of constant hunger in spite of full diet. During the period the patients were in hospital after operation, there was an increase in weight of all patients. This gain in weight could

not be ascribed to any special diet, rest or nursing, as such increase was not found in the post-Insulin or Cardiazol shock therapy period, though the post-shock and the post-operative periods were similar in diet, nursing, rest, etc. On the psychological side, in the immediate post-operative period, in a large number of cases, there is a profound change; violence has given place to quiet, bellicosity to modesty, the voices that used to whisper have been silenced, and the hallucinations have disappeared. The general demeanour is one of calm placidity. This change in the patient is progressive and maintained.

*Complications* after this operation are met with though not frequently. Some are transient and a few are persistent. Our experience has been more fortunate than the workers in Europe and the few complications that we have met with, like, headache, incontinence of urine, anisocoria have been transient.

*Haemorrhage* during the operation or soon after is the most serious, and has been the cause of a high proportion of fatal results. The source of haemorrhage is either from the main trunk of the anterior cerebral artery on the medial surface of the brain, due to the introduction of the leucotome to a greater depth than is correct or from one of its branches situated at the bottom of a sulcus of grey matter.

*Complications* met with by other workers are incontinence of urine lasting for one to three months, and sometimes permanently, anisocoria, Argyll-Robertson pupil, ptosis, nystagmus, etc. These are usually temporary and not of great moment. More severe, and producing mental deterioration, are, convulsions, restlessness and violence, tremors and fibrillary contractions of the platysma and the masseter muscles. They are of grave prognosis and often terminate fatally. Paralysis of varying intensity like hemiplegia, monoplegia, aphasia, sphincter disturbances associated with diarrhoea have been reported, and are to be viewed with concern when met with.

In spite of the formidable list of complications, an encouraging feature of this operation is the low mortality. Freeman had three deaths in thirty-one cases, Dax and Smith 2 in 50 cases. In our series of 75 cases up to November 1945, we had one death on the tenth day of the operation, as a result of an accident with the leucotome inside the brain. Excepting this, we have had no death attributable to the operation.

**Selection of cases for the operation.**—No definite conclusion have been arrived at as to the most suitable type of case for leucotomy. Cases are chosen only after every other known type of treatment has been given a thorough trial and failed, and should be reasonable operative risks. It is our impression that the chances of improvement after leucotomy depends on the patient's prepsychotic personality, family history, intellectual attainments, and the duration of the disorder.

The *results* of treatment of mental diseases are difficult to assess accurately as changes in the personality of the patient after the operation. In cases which show improvement the maturation of the personality may occur even after weeks or months. Initiative and capacity for constructive thinking increases with time.

Following the initial period of lethargy and disorientation after leucotomy which seldom lasts more than a week, a period of relaxation supervenes. Progress depends a good deal on the prepsychotic personality of the patient, the duration of the psychosis, and the stereotyped nature of the complaints or compulsions. Once the patient returns to his home in about four weeks after the operation, the newly emerging personality is developing and continues its evolution for a period of many months or even years.

A psychological survey of our first fifty cases operated on between 1942 and 1944 has been done by Mr. Vasudeva Rao, Psychologist at the Mental Hospital, Bangalore, and the following are portions from a paper sent for publication.

A patient is said to have 'recovered' when the leucotomy has helped him to regain the original place in the family setting and in the socio-religious sphere, his general health is satisfactory, and is able to follow his occupation.

A patient is said to have 'improved' when his general health is satisfactory, the symptoms for which the patient was admitted to the hospital have disappeared and no new ones have developed, but his adjustment to occupational and socio-religious life is not satisfactory.

The following table shows the effect of leucotomy in our first fifty cases, some of them performed over three years ago, but none of them less than a year ago.

RESULTS OF LEUCOTOMY IN THE  
FIRST FIFTY CASES

SEX	Recovered	Improved	Un-changed	Re-admitted	Remaining	Dead	Not traced	Total
MEN	8	9	5	4	6	2	1	35
WOMEN	3	6	2	1	2	1	...	15
TOTAL	11	15	7	5	8	3	1	50

The three deaths in this series were not primarily due to the operation but due to the operation but due to emotional oscillations of high intensity lasting for several days, occurring a considerable time after operation.

The following is a typical case history in the group 'recovered.'

Case No. 13.—Mrs. K., aged 25 years. Suffering from chronic maniac depressive state. Has two children, husband employed in government service. No trace of psychoneurosis in the family. Average intelligence, literate in two languages. Duration of disorder seven years.

At the time of admission she had :

- (1) Emotional depression and morbid preoccupation.
- (2) Refused to answer questions.
- (3) Indifferent to personal cleanliness.
- (4) Hostility towards husband and children.
- (5) Shuns the company of others.

Bilateral prefrontal leucotomy was performed on 26-3-43. Convalescence was uneventful and discharged from hospital two weeks later. In September 1945, the husband was seen and reports that the patient is exceedingly well. Eats and sleeps well. Is very happy at home with husband, children and others in the family. Went through a child birth quite normally. Is attending a ladies club, and does knitting and embroidery. Is well adjusted martially and socially after nearly seven years of illness.

The following is a typical case history in the group 'improved.'

Case No. 27.—Mrs. K. P., aged 45 years. Severe case of chronic depression. Has two children, the younger aged 25 years. Husband in very good social position. No evidence of neurotic or psychotic traits in the family. Duration of disorder 19 years.

At the time of admission she had :—

- (1) Poor general health.
- (2) Indifferent to personal cleanliness and filthy habits.
- (3) Indifferent to members of the family. Would not recognise her husband and children.
- (4) Incoherent and irrelevant murmuring utterances.
- (5) Seclusive.
- (6) Would eat only when fed.

Bilateral prefrontal leucotomy performed on 23-10-43. Was discharged from hospital after four weeks when she had shown considerable improvement in her condition. The husband in reply to a query writes that she is well. Attends to her household duties, eats and sleeps well. Dislikes the company of members that are not of the family, and avoids participating in social functions where there are large number of people.

The following table shows the distribution of cases according to the duration of disorder.

RESULTS OF LEUCOTOMY IN RELATION TO 'DURATION OF ILLNESS'  
(50 CASES)

Duration of disorder	Recovered	Improved	Unchanged	Readmitted	Remaining	Dead	Not traced
0—1 year	3	1	1	1	1	1	1
1—5 years	5	5	3	2	1	...	...
5—10 "	1	3	1	...	2	1	...
10—15 "	1	2	2	...	1	...	...
15—20 "	1	2	...	1	1	1	...
Not known	...	2	...	1	2	...	...
Total ...	11	15	7	5	8	3	1

These figures indicate that the best results are obtained in those cases where the duration of disorder is between 1—5 years, though improvement has been noticed in some cases where the duration has exceeded 10 years.

The following table shows the distribution of cases according to the disease process.

RESULTS OF LEUCOTOMY IN RELATION TO 'NATURE OF ILLNESS'  
(50 CASES)

	Schizophrenia	Catatonic	Paranoid	Affective Reaction	Mental Defect	Total
Recovered ...	4	...	...	7	...	11
Improved ...	5	...	...	10	...	15
Unchanged ...	1	1	3	1	1	7
Readmitted ...	2	...	...	3	...	5
Remaining ...	1	...	6	...	1	8
Dead ...	...	...	...	3	...	3
Not traced ...	1	...	...	...	...	1
Total ...	14	1	9	24	2	50

The above table suggests that the greatest improvement occurs in those showing an affective reaction. The schizophrenics show good response, while the catatonics and the paranoid states showed practically no improvement.

The failure of improvement in operated cases can be attributed to two main causes. One is due to the duration of the disease and degenerative changes in the brain which will have supervened consequent on the illness. In such cases obviously it is not possible to expect any marked improvement. The other cause is due to the plane of section being far too anterior to the plane of critical section. If the cut is too anterior no improvement results, and cuts made posterior to this plane are dangerous, and often produce permanent motor damage, sphincteric disturbances, epileptiform seizures, etc. Freeman and Watts have subjected about 20% of their cases to a second and sometimes a third operation, the sections being made posterior to the previous operation. They have found improvement

after the second or even third operation, and recommend it in cases which have not responded to the first operation. Our experience is limited to one case, submitted to a second operation where more extensive sections of the white matter than at the first operation was done, and a small quantity of absolute alcohol was injected into the sectioned area. The patient is alive and though slight improvement is noticeable, it is too early to hazard an opinion on one case only. It is intended to perform a second operation on a few more cases who have failed to show any improvement after the first operation.

Criticism of this operation is neither wanting nor unexpected. But as more workers in the field have demonstrated the usefulness of the operation, and the hopeless cases at least have a chance of improvement, hostility to the operation is gradually fading.

The future of psycho-surgery is uncertain. Without a precise knowledge of the mechanism underlying the various mental processes both normal and abnormal, one can only surmise as to the method of treatment or the possible outcome of such treatment. Certain mental disorders appear to have some sort of racial characteristics, and sufficient reports of this method of treatment appears desirable in our country before the true position of psycho-surgery could be assessed.

I take this opportunity to thank Dr. V. V. Monteiro whose kind encouragement, made this work possible. My thanks are also due to Dr. M. V. Govindaswamy, Superintendent, Mental Hospital, Bangalore, for enthusiastic co-operation in conducting this work.

In conclusion Mr. President, Ladies and Gentlemen, I thank you for the patient hearing you have given me, and if this brief description has evoked the enthusiasm of my fellow workers to try this method, the purpose of this lecture would have been more than served.

## ASSOCIATION NOTES

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### Registry of Sarcoma of Bone

It was decided at the last Conference that a Registry of Sarcoma of Bone is to be maintained under the auspices of the Association. Dr. V. R. Khanolkar of the Tata Memorial Hospital, Bombay, has very kindly consented to make the necessary Pathological study of Specimens. All Surgeons are, therefore, requested to send short but complete notes of cases of Sarcoma of Bones under their care to Dr. Khanolkar along with X-Ray and Clinical photographs, if any, and a piece of embedded tissue or two unstained slides. It is particularly requested that all Surgeons will co-operate in this endeavour.

### The Library

The attention of all members is invited to the Circular regarding the Library. A separate account has been opened and donations and subscriptions may be sent to the Secretary. Suggestions regarding books and journals to be acquired are welcome. Donations will be acknowledged in the Journal from time to time.

#### List of Donors

(Since publication of the previous list)

Capt. V. L. Suryavanshi	..	Rs.	50	0	0
Previous total	..	„	3,457	0	0
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### Subjects for Discussion

#### 8th Meeting :

##### 1. Carcinoma of the Rectum—

Opener : Dr. C. P. V. Menon, Madras.

Seconder : Dr. E. J. Borges, Tata Memorial Hospital, Bombay.

##### 2. Carcinoma of the Cheek—

Opener : Dr. B. M. Joly, Delhi.

Seconder : Dr. K. M. Rai, Madras.

##### 3. Hare Lip and Cleft Palate—

Opener : Dr. S. C. Sinha, Calcutta.

Seconder : Dr. M. G. Kini, Madras.

#### 9th Meeting :

##### 1. Bone Tumours—

Opener : Dr. D. R. Meher Homji,  
Bombay.

Seconder : Dr. M. G. Kini, Madras.

##### 2. Intracranial Tumour—

Opener : Dr. A. V. Baliga, Bombay.

Seconder : Dr. R. N. Cooper, Bombay.

##### 3. Burns—

Opener : Dr. M. R. Munawar Ali,  
Hyderabad.

Seconder : Dr. G. M. Phadke, Bombay.



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No. 1

## INFECTIONS OF THE FOOT\*

by V. RAMACHANDRA RAO, M.B.B.S., Stanley Hospital, Madras.

### 1. Introduction

The Problem of 'Infections of the Foot' has not received the same attention as that of 'Infections of the Hand' in Western countries. A good deal of work has been done with regard to infections of the hand as the prehensile function of the hand makes it susceptible to injuries and infections with ultimate limitations of function and even loss of certain important and fine movements. The Foot acts as a support and helps stability and locomotion, and being well protected, by a thick layer of fat in the sole and a boot or a shoe in addition, is not liable to injuries and infections. Perhaps this accounts for the lack of interest in the investigation of infections of the Foot in Western countries. In India, however, particularly in the south, most people go barefooted and the Foot is more exposed to injury and infection. Protecting nervous reflexes in the hand help in withdrawing it quickly. But the Foot has to wait transference of the gravitational weight to the other limb before it can be withdrawn. Thus a split second is enough to cause many a road accident and being bare as it is in India the Foot gets easily injured and often seriously infected. The tropical climate also has a special bearing on the production of a variety of clinical manifestations.

### STATISTICAL REVIEW

On the average about 21.1 per cent of the new cases that attend the surgical outpatient department in our hospital suffer from some surgical condition or other of the Foot.

In the month of September 1943 the total number of patients that attended the Sur-

gical Out-patients was 1758 including males, females and children. Of these, 384 patients sought treatment for some surgical condition or other of the Foot. This gives a percentage of 21.8. The corresponding figures for October 1943 were 351 cases out of 1624 giving a percentage of 21.5. In June 1945, the figures were 299 out of 1505—a percentage of 19.9. This shows the high affections of the foot (Fig. 1).



Fig. 1. Long Column shows the Total Attendance of Surgical Cases. Short Column indicates the No. with Foot involved.

\*Prize Essay.

TABLE I

TOTAL NUMBER OF PATIENTS WHO  
ATTENDED THE SURGICAL OUT-  
PATIENT DEPARTMENT

Month & Year	Males	Females & Children	Total
September 1943	1156	602	1758
October 1943	1121	503	1624
June 1945	994	511	1505

TABLE II

NUMBER OF PATIENTS PRESENTING  
A SURGICAL CONDITION OF FOOT

Month & Year	Ulcers		Abscesses		Infective conditions	Injuries	Total
	Acute	Chronic	In Heel	In other parts			
Sept. 1943							
Males		23	13	15		220	271
Females & children		10	8	15		80	113
Total ...		33	21	30		300	384
June 1945							
Males	15	35	8	8	8	149	223
Females & children	7	18	6	5	9	31	76
Total ...	22	53	14	13	17	180	299

TABLE III

Month & year	Total No. of patients attending the Surgical Out-patients	Total No. with Foot involved	Percentage
September 1943	1758	384	21.8
October 1943	1624	351	21.5
June 1945	1505	299	19.9
Average ...			21.1

The first paper on 'Infections of the Foot' was written by Grodinsky entitled 'Fascial spaces and tendon sheaths of the Foot and

their bearing on Infections of the Foot,' and was published in 1929 and 1930 in Surgery, Gynaecology and Obstetrics. In the next year, Grodinsky published another paper entitled 'Foot Infections of Peridigital origin' in the Annals of Surgery. Barring these papers, it can be said that very little has been written concerning 'Foot and its Infections.' In recent years however, many papers are being published in various Indian journals on 'Naga Sores or Tropical Ulcers in the Foot and Leg' throwing light on the aetiology and suggesting methods of promoting effective and rapid healing of these ulcers.

## 2. Anatomy of the Foot with particular reference to Foot Infection

### I. FASCIAL SPACES OF THE FOOT

Grodinsky has described 11 fascial spaces of which 9 are in the foot and 2 in the leg. Of these 9 spaces in the foot 7 are in the sole. There are 4 median plantar spaces, 1 medial and 1 lateral plantar space and another in connection with the lumbricals—the lumbrical space. The two dorsal spaces described are the dorsal subcutaneous and the sub-aponeurotic. Of the two spaces in the leg one is the medial leg space which is between the superficial and deep calf muscles brought into relation with the foot by the long flexor tendons behind the medial malleolus and the other the lateral leg space, deep to the sheaths of the peroneal tendons which extend behind the lateral malleolus towards the foot.

With the object of defining and determining the extent of these spaces, their relation with one another and with the tendon sheaths, dissection and injection work was carried out on ten limbs, including fresh and preserved.

A description of the various foot spaces is given below. Among the four median plantar spaces three are between the four layers of the muscles and one between the first layer and the plantar aponeurosis. They are described as M-I, M-II, M-III, and M-IV.

## MEDIAN PLANTAR SPACE I—M-I

(Figure 2, 3.)

This space is deep to the central part of the plantar aponeurosis and superficial to the flexor digitorum brevis muscle. The lateral and medial boundaries are connective tissue down growths from the plantar aponeurosis which are continuous with those of M-II. Posteriorly, the aponeurosis



Fig. 2. Superficial plantar view of human foot, showing plantar aponeurosis and related structures.

and the flexor digitorum brevis are closely united together. Proximal to the level of the midtarsal joint the central part of the plantar aponeurosis and the flexor digitorum brevis are strongly bound together and any attempt to separate them lacerates the one or the other. The space does not extend posterior to this level for all practical purposes. The compartment ends anteriorly at about the level of the middle of the metatarsal bones where the fasciae covering the floor and the aponeurosis fuse together. Along the length of the space fine but fairly firm connective tissue septa go down

from the deep aspect of the aponeurosis into the fascia over the flexor digitorum brevis, thus dividing the space into four anteroposterior compartments, there being one proximal to each of the four subcutaneous spaces between the slips of the plantar aponeurosis. Distally these septa are incomplete and hence all the four compartments freely communicate with each other. This has been made more evident during injection work when the fluid distends the space part by part and in an anteroposterior direction.



Fig. 3. Both Feet—The central part of the plantar aponeurosis reflected in two flaps to the sides exposing the median plantar space M-I Flexor Digitorum Brevis is seen in the floor. In both feet plaster mass injected into the heel is seen, the mass in the right foot colour-painted for better definition.

Grodinsky has further stated in his paper that "each of the four compartments is partially subdivided by partially incomplete transverse septa particularly at the level of the base of the fifth metatarsal bone where the first and fourth end proximally. The second is the longest and extends posteriorly to within two or three centimeters of the medial tubercle of the calcaneus. The third is the shortest and runs into the second 2.5 cms. distal to the base of the fifth metatarsal bone." These details could not be appreciated during my dissection work.

down from the plantar aponeurosis and bounds likewise M-I and M-III. Medially it is limited by the septum that goes down from the medial margin of the central part of the aponeurosis and likewise bounds M-I, M-III and M-IV. Anteriorly, it extends as a distinct space only upto a line opposite the base of the fifth metatarsal bone where

(Figure 4 and 5)

This space is triangular in shape, superficially bounded by the flexor digitorum revis and the plantar aponeurosis and deeply, by the quadratus plantae muscle joined medially by the flexor digitorum longus tendon. It lies between the fascial sheaths of the two muscles mentioned above and their reflexions at the periphery.

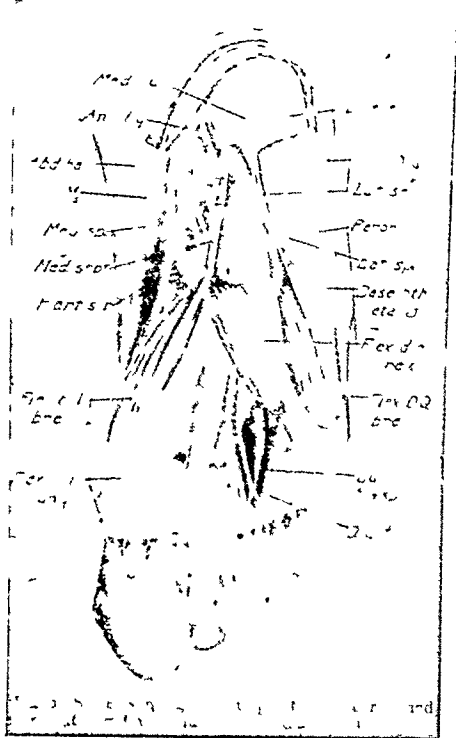


Fig. 4. Same as in Figure 2 but plantar aponeurosis and flexor digitorum brevis muscle reflected anteriorly.

The apex of the space is about one centimeter anteromedial to the medial tubercle of the calcaneus. Laterally, it is limited by the connective tissue septum which goes

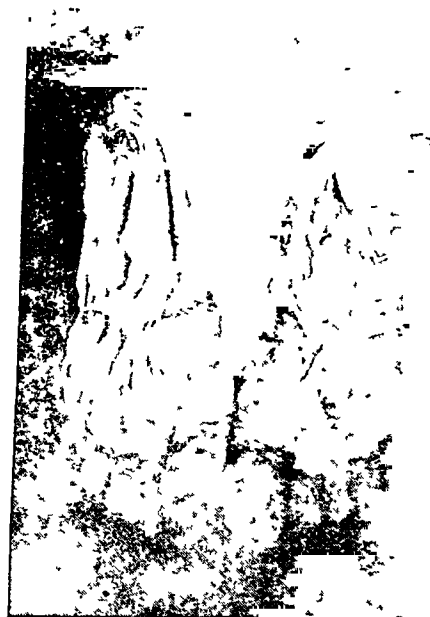


Fig 5. Both Feet—Flexor Digitorum Brevis reflected in two flaps (anterior and posterior), exposing M-II.

Left Foot—Note plantar vessels and the lateral plantar nerve coursing across the space antero-laterally. Still anteriorly the tendons of the long flexor digitorum to the toes are seen.

Right Foot—The plaster mass injected into M-II is seen. The nerve and vessels are seen coursing across the space superficial to the mass.

the fascia of the roof and the floor are joined by loose areolar tissue, thus forming the base of the triangular space. This loose areolar tissue can be easily broken through when it will be found that the space extends into the interspaces between the slips of the plantar aponeurosis (Vide page 12).

### MEDIAN PLANTAR SPACE III—M-III

(Figure 6 and 7)

This is another triangular space deep to M-I and M-II. The roof is formed by the deep surface of the quadratus plantae muscle. The floor consists of tarsal bones and ligaments posteriorly, the tendon of the peroneus longus with its synovial sheath in the middle and the adductor hallucis obli-

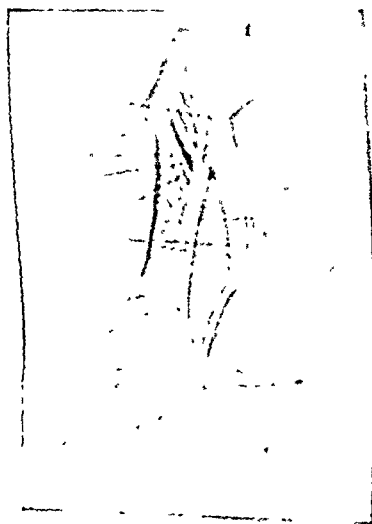


Fig. 6.

quus and the plantar and dorsal interossei between the third, fourth and fifth metatarsals, anteriorly. The medial limitation is the same connective tissue septum going down from the plantar aponeurosis and bounding M-II, M-I and M-IV. Due to the concavity of the main arch of the foot and in conformity with one half of the transverse arch in each foot, the lateral boundary consists chiefly of the tarsal bones and ligaments (especially the long plantar ligament) posteriorly and the third plantar and fourth dorsal interossei, anteriorly. The apex of the space is about 2 or 3 cms. anterior to that of M-II, i.e., about 3 to 4 cms. anteromedial to the medial tubercle of calcaneus, being more anterior than medial. The anterior extent of the base of the space is along a line passing through the middle

of the fifth metatarsal bone and the head of the first one. Further anteriorly the two lateral spaces are separated by the same septal tissue which can be easily separated.



Fig. 7. Left Foot. Skin and plantar aponeurosis removed. The abductor digiti quinti and adductor hallucis detached from their calcaneal attachments, and thrown to the sides thus exposing the medial and lateral plantar spaces.

The central part of the plantar aponeurosis and the flexor digitorum brevis are also removed. The long flexor digitorum cutaneous and thrown forward exposing M-III. Note the abductor hallucis obliquus in its distal part. The medial and lateral plantar septa are demarcated.

This space M-III thus extends forwards like M-II and M-I in between the slips of the plantar aponeurosis towards the lateral four toes (Vide page 12).

### MEDIAL PLANTAR SPACE IV—M-IV

(Figure 8 and 9)

This is a potential space deep to the Adductor Hallucis obliquus and superficial to the first dorsal interosseus in the first metatarsal interspace, the proximal half of the first plantar and second dorsal interossei in the second space and the proximal ends of the second plantar and third dorsal interossei in the third interspace. The medial connective tissue septum going down and getting attached to the lateral side of the first metatarsal bone along its length splits to enclose the Adductor Obliquus Hallucis,

thus affording it a fascial sheath and also forming the medial boundary of M-IV. The lateral boundary is the sheath of the muscle along its lateral border which is on a line between the base of the 4th metatarsal and the lateral aspect of the base of the proximal phalanx of the great toe. The space is deep to the muscle entirely between it and its fascial sheath. The plantar arch and vessels lies for the most part deep

with its sheath is in relation to the lateral plantar space (vide page 8). Thus it can be seen that infection in the sheath can spread into one or all of these spaces. M-III is a very important space in the sense that it communicates with lateral plantar space as stated above, and with the medial plantar space deep to the flexor hallucis longus and

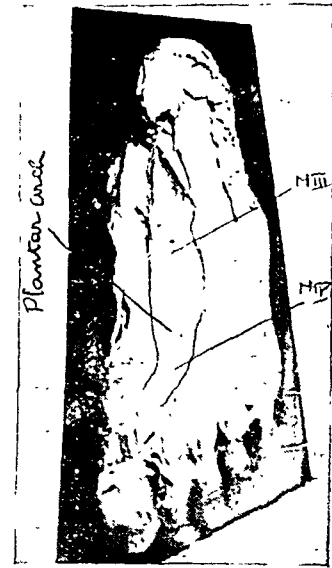
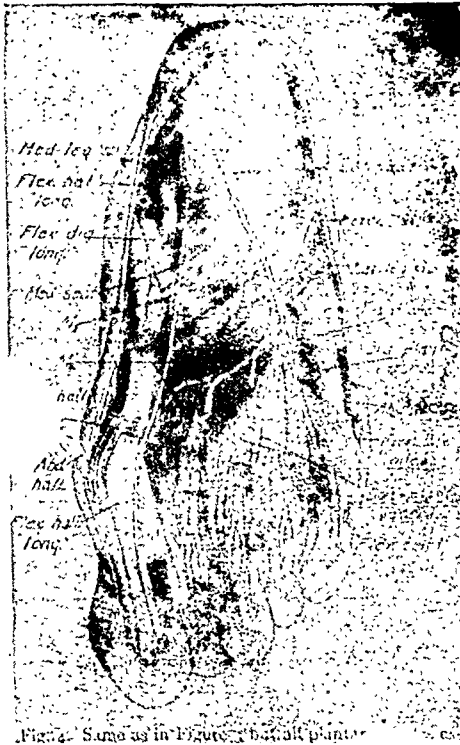


Fig. 9. Left Foot.

The Abductor Hallucis and the Abductor Digiti quinti removed. The flexor tendons severed at a level just proximal to the necks of the metatarsals. The abductor obliquus also removed. M-III and M-IV are visualised. The plantar arterial arch is seen in the floor of M-IV.

the flexor digitorum longus tendons as they pass through its medial wall. M-IV is virtually in M-III. Infection can spread through the interossei into the dorsal sub-neurotic space due to the absence of any fascial layer covering the meta-the interossei (vide page 13).



to their sheaths and to the transverse metatarsal ligament on each side of the toe. All the five processes are held together by transverse fibres, and between them appear the digital vessels, nerves and the lumbrical muscles. From the deep surface of each slip pass firm connective tissue septa. The interspaces between these slips of plantar aponeurosis are occupied by subcutaneous fatty tissue which is a part of the superficial fascia. In the substance of this fascia run the common digital nerves surrounded by their fascial sheaths derived from the fascial floor of M-I. They are joined distally by the plantar metatarsal vessels which become superficial near the necks of the metatarsal bones. If the nerve and the vessel be dissected out and cleared of the superficial fascia, the lumbrical muscles are exposed covered by a fairly firm layer of fascia extending between the lateral walls of the lumbrical grooves. Superficial to this fascia these subcutaneous interspaces can be traced proximally upto the place where the central part of the aponeurosis divides into strips. At that level fairly dense connective tissue is seen to bind the deep part of the plantar aponeurosis to the fascia below. When this is teased, it is found to open into M-I—into each one of its four common compartments, wherein emerge the common digital nerves from M-I deriving a sheath from its floor. When the fascia covering the lumbrical grooves is removed the lumbrical muscles are exposed, each enclosed in a thin fascial sheath which is derived from the floor of the M-II space as they arise from the digital slips of the long flexor tendon. The slips of the flexor digitorum brevis cross the lumbrical muscles at their origin superficially from the medial to the lateral side. The digital slips of the longus digitorum are always to their lateral side. Both the flexor tendons of each toe are lateral to the lumbrical tendon in their distal course. These flexor tendon slips derive their own fascial sheaths from the muscles from which they arise. These correspond to the paratendinous sheaths of the hand and are reinforced by the deep bands from the plantar aponeuro-

sis to form the lateral walls of the lumbrical tunnels. This is in agreement with Grodinsky's findings (Fig. 2, 4, 11).

This potential space between the lumbricals and their fascial sheath is separated from M-II by a thin layer of loose areolar tissue which easily breaks through and thus connects one with the other. Distally the lumbrical tendon while gaining insertion into the dorsal expansion extends into the dorsal subcutaneous region. The lumbrical space communicates with the dorsal subcutaneous space also. Deep to each lumbrical muscle and its sheath lies loose areolar tissue which when traced proximally is found to be the same as that which lies below the fascia covering M-III space and binds them down loosely (vide page 13).

### MEDIAL PLANTAR SPACE

(Fig. 2, 4, 10, 7)

The Medial Plantar Space is the potential space deep to the Abductor hallucis muscle—between it and its sheath. It extends from the origin of the muscle from the calcaneus to its fusion with the medial head of the flexor hallucis brevis muscle. The fascial sheath deep to this space forming its floor covers the posterior tibial vessels and nerves and the tendons of the long flexors of the digits and the hallux as they emerge from behind the medial malleolus and pass to the sole of the foot. Deep to this fascial sheath or a little higher up the posterior tibial structures divide into the terminal medial and lateral plantar branches. The space is limited medially by the fusion of the fascial layer deep to the muscle and the medial border of the muscle itself. While laterally the same fascia fuses with the medial fibrous down growth from the plantar aponeurosis.

### LATERAL PLANTAR SPACE

(Fig. 2, 4, 10, 7)

It is the potential space underneath the abductor digiti quinti muscle. It is enclosed in the fascial sheath of the muscle deep to

it. The sheath fuses with the lateral border of the lateral slip of the plantar aponeurosis along the lateral border of the muscle thus limiting it on that side. Medially the fascia fuses with the lateral fascial down growth from the lateral aspect of the central part of the plantar aponeurosis. The space extends from its origin to its insertion. The abductor digiti quinti takes origin from the calcaneus deep and inner to the origin of the lateral part of the flexor digitorum brevis. The lateral plantar septum also passes deeply and inwards between the two muscles. Thus the proximal position of the lateral plantar space is between the M-II and M-III spaces. The peroneus longus tendon passes deep to the floor of the space in its proximal part as it crosses across the sole antero-medially emerging from behind the lateral malleolus.

### DORSAL SUBCUTANEOUS

(Fig. 10 and 11)

It is an extensive space deep to the skin and superficial fascia and is continuous with the same space in the leg. As in the hand it receives the insertion of the lumbricals from the sole as they join the extensor expansions in the space.

### DORSAL SUB-APONEUROTIC SPACE

(Fig. 10 and 11)

It lies deep to the deep fascia overlying the extensor tendons and superficial to the dorsal interosseus muscles. The extensor tendons pass through the space.

### THE MEDIAL LEG SPACE

It is the space in association with tendons of the long flexor of the digits and the hallux and that of the posterior tibial. The space extends upwards between these muscles and the superficial calf muscles namely the gastrocnemius and the soleus. Its proximal limit corresponds to the origin of the soleus from the tibia and the fibula at the junction of their middle and upper one-thirds. The posterior tibial vessels and

nerve pass through this space. Below in the sole, the space lies deep to the fascial floor of the medial plantar space and is limited by the medial plantar septum going down from the plantar aponeurosis and affording limitation also to the median plantar, M-I, M-II and M-III spaces.

### LATERAL LEG SPACE

With the sheaths of the peronei tendons a space can be traced up from behind the lateral malleolus into the lateral compartment as far as the upper one-third of the leg. A break through this space posteriorly brings this into connection with the large medial leg space between the long flexor muscles and the superficial calf muscles, while anteriorly the space is limited subcutaneously. This space is deep to the fascia of the floor of the lateral plantar space in the foot and limited distally by the lateral plantar septum which shuts it off from M-I, M-II and M-III.

### II. TENDON SHEATHS IN THE FOOT AND LEG

The tendon sheaths in the foot and leg can be divided into five groups (Figure 12 and 13):—

- (i) The sheaths of the flexor tendons of the toes.
- (ii) The sheaths about the long flexors and the tibialis posterior behind the medial malleolus.
- (iii) The sheaths about the peroneal tendons behind the lateral malleolus.
- (iv) The sheath of the long peroneous tendon in its course across the sole of the foot.
- (v) The sheaths of the extensor tendons on the dorsum of the foot and the ankle.

### (i) SHEATHS OF THE FLEXOR TENDONS OF THE TOES

(a) *Sheath of the flexor hallucis longus tendon.*—The distal limit of the synovial

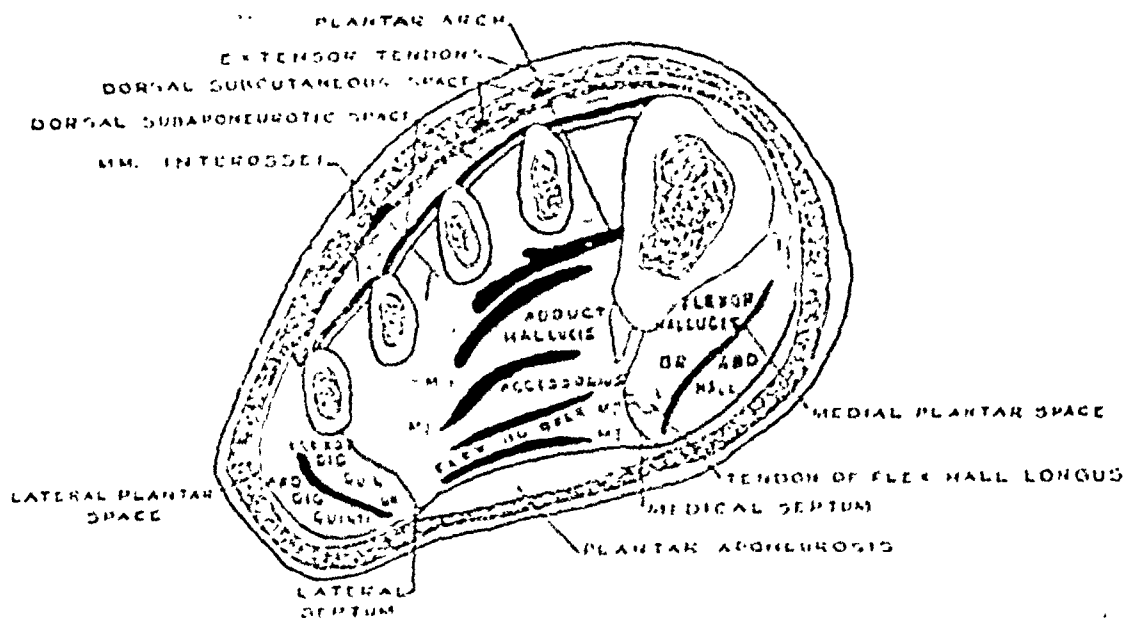


Fig. 10. Cross Section Foot.  
Level of Vth Metatarsal Bone—(Proximal Surface)

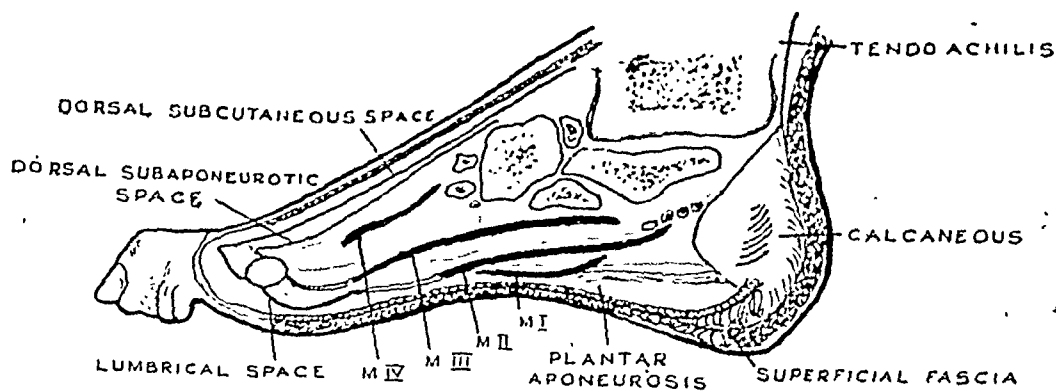


Fig. 11. Sagittal Section Foot.  
Between Second and Third Toes—(Lateral View)

former in the foot (M. Grodinsky 1930). In two out of 7 cases the communication was observed by Poirier and Rouviere (1912). The sheath of the flexor digitorum longus tendon may communicate with that of the tibialis (posterior (M. Godinsky—one case 1930). In one of the four limbs dissected the tendon sheath of the flexor hallucis longus communicated with that of the flexor digitorum longus. The communication between the flexor digitorum longus and the tibialis posterior was not observed in any of the four cases.

The tendon of the flexor hallucis longus muscle in its course under the annular ligament passes through a fibrous canal deep to the posterior tibial nerve and vessels.

*The Ligamentum Laciniatum*: bridges across the hollow between the medial malleolus and the medial prominence of the calcaneus, and it attached to both. Its proximal border is continuous with the deep fascia covering the superficial muscles of the calf and also with the septum which separates these muscles from the deeper muscles of the leg. The septum takes a more important part in the formation of the ligament than the more superficial layer of deep fascia. Its distal or anterior margin is continuous with the medial part of the plantar aponeurosis and it gives attachment to the abductor hallucis muscle. The tendons that are deep to it are isolated from one another and from the vessels and nerve by septa which pass from the deep surface of the ligament to the ridges on the adjacent bones.

### (iii) SHEATHS AROUND THE PERONEUS LONGUS AND BREVIS AS THEY PASS BEHIND THE LATERAL MALLEOLUS

The two tendons have a common serous sheath to start with, which divides distally into two divisions one for each tendon. The proximal end of the common sheath lies three to six cms. above the tip of the lateral malleolus. The sheath of the brevis tendon is anterior to that of the longus in its lower portion. The distal end of the brevis divi-

sion extends to very near its insertion. In one half of the specimens it extended to almost its insertion into the base of the fifth metatarsal and the other half to a point midway between the tip of the malleolus and the point of its insertion (Grodinsky). Distally the longus sheath ends obliquely, extending further into the foot on the deep side than on the superficial side. Superficially it ends where the tendon bends sharply into the sole—a point 2 to 3 cms. distal to the base of the fifth metatarsal bone or 3 to 4 cms. inferior to the tip of the lateral malleolus. In two out of four cases the sheath of the peroneus brevis extended to the base of the fifth metatarsal bone. In the third case it stopped short  $1\frac{1}{2}$  cms. and in the fourth 4 cms. from the base of the fifth metatarsal bone.

As the tendons of the two peronei muscles proceed distally, in the hollow between the lateral malleolus and the posterior prominence of the calcaneus, they are held in place by the SUPERIOR PERONEAL RETINACULUM and their movements are facilitated by the common synovial sheath enclosing them. On the lateral surface of the calcaneus, the tendons are retained in position by the INFERIOR PERONEAL RETINACULUM, but each tendon lies in a separate compartment with a separate synovial sheath prolonged from the common peroneal sheath. The trochlear process of the calcaneus intervenes between the two tendon sheaths of the peronei when that of the brevis is higher than that of the longus.

### (iv) PLANTAR SHEATH OF THE PERONEUS LONGUS

Distally the plantar sheath extends almost to the insertion of the tendon on the first cuneiform bone and the base of the first metatarsal. The proximal portion may be in contact with the distal deep end of the malleolar sheath of the same tendon or may be about a centimeter distant from it. The two sheaths may communicate rarely (one in 7 cases—Grodinsky, Poirier and Rouviere—frequently, 1912). This plantar peroneal sheath is incompletely enclosed in



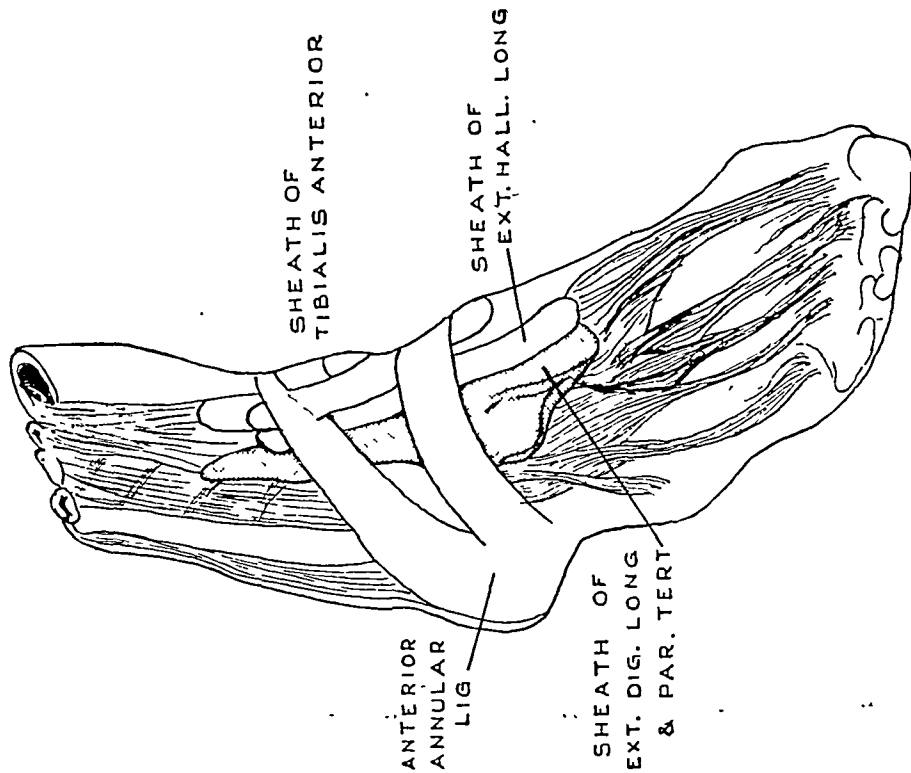


Fig. 12. Dorsal View—Extensor Tendons.

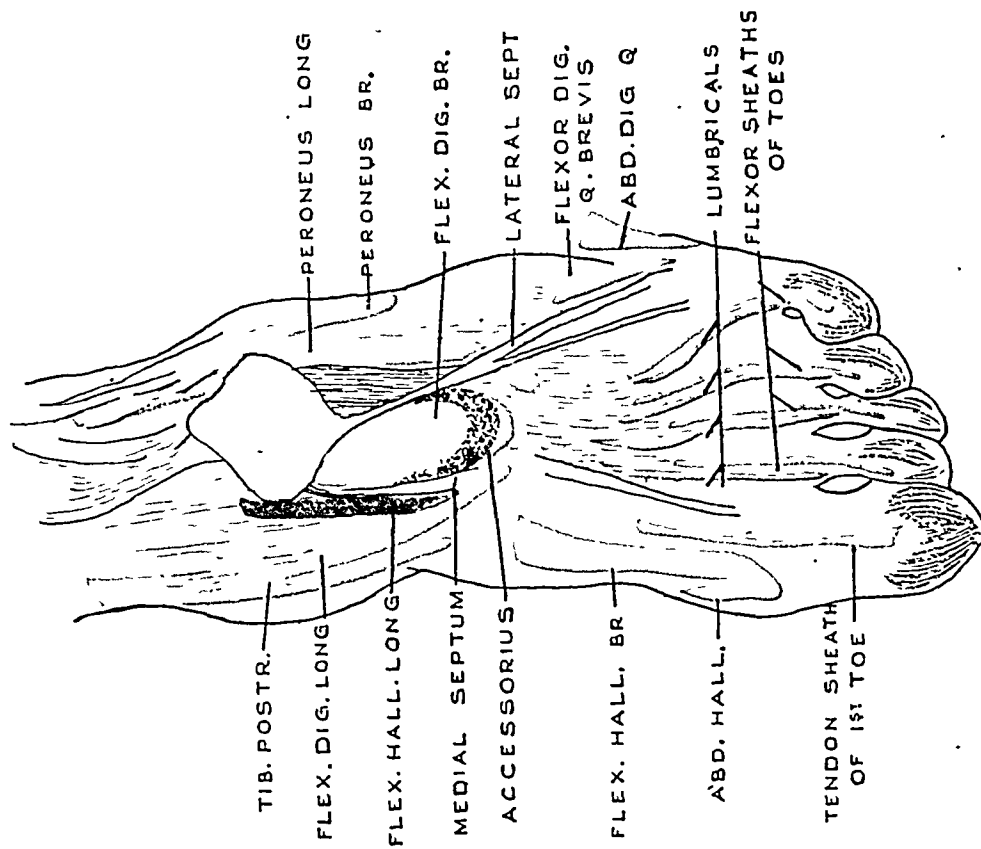


Fig. 13. Plantar View—Flexor and Peroneal Sheaths.

a fibrous investment derived from the long plantar ligament and the tibialis posterior tendon which affords its origin in part to the adductor hallucis obliquus. No communication was noted between malleolar and plantar peroneal sheaths in any of the four cases dissected.

#### (v) TENDON SHEATHS OF THE EXTENSOR TENDONS IN FRONT OF THE ANKLE AND OVER THE DORSUM OF THE FOOT

(a) *Tendon sheaths of the extensor hallucis longus*.—Proximal extent 1 to 2 cms. above a line joining the tips of the malleoli and distal limit 4 to 6 cms. below it. The tendon sheath extended upto 1 cm. proximal to its point of insertion in two out of the four limbs dissected.

(b) The sheath of the extensor digitorum longus ends proximally 1.5 to 3 cms. above the inter-malleolar line and distally 3 to 4.5 cms. below the same line.

(c) The corresponding limits of the tibialis anterior tendon sheath are 4 to 5.5 cms. above and  $1\frac{1}{2}$  to 5 cms. (varying) below the inter-malleolar line.

#### THE ANTERIOR ANNULAR LIGAMENT (LIGAMENTUM TRANSVERSUM CRURIS ET LIGAMENTUM CRUCIATUM)

The transverse ligament stretches across the lower end of the tibia and fibula getting attached to both of them. It contains a distinct compartment for the tibialis anterior tendon and its sheath while the tendons of the extensor digitorum longus and hallucis longus pass deep to it. The cruciate ligament consists of two layers. These, by separating at certain points and becoming reunited at others, form three distinct compartments. The tendon of the tibialis anterior passes through the medial compartment, the tendon of the extensor hallucis longus traverses through the intermediate one and the tendons of extensor digitorum longus and the peroneus tertius are transmitted through the lateral compartment. The anterior tibial vessels and the peroneal

nerves as they pass down under cover of these ligaments lie between the extensor hallucis longus and extensor digitorum longus.

"Structurally the tendon sheaths are completely closed sacks with visceral and parietal layers which are in continuity on the deep side of the tendons, much as the visceral and parietal layers of the peritoneum are in forming the mesenteries (Poirier and Rouviere 1912). Between these reflections the nutrient vessels enter these tendons. In the case of the digital sheaths, however, the meso-tendons have been reduced in extent so as to be confined to the regions of the vincula which connect the superficial and deep tendons to the bones and to each other (Trieves 1927; Piersol 1923). Similarly in the case of the flexor sheaths of the tendons behind the medial malleolus, the meso-tendons are formed only at the extremities extending in a postero-medial direction. The meso-tendon of the common peroneal sheaths (malleolar) extends from the upper extremity of the sheath to the lower border of the malleolus lying at the postero-lateral side of the tendons. That of the plantar peroneal sheath is confined to the distal third of the sheath of its deep side and to the proximal third on the lateral side. On the other hand, the extensor tendons have meso-tendons extending the entire lengths of the sheaths and lying at the postero-lateral side of the tendons." These points could be very well appreciated upon dissecting a fresh specimen.

Great care should be taken to open these sheaths from the opposite sides to where these meso-tendons are situated, and to abstain from lifting these tendons from their beds, lest the already inflamed meso-tendons be destroyed and the vessels running through ruptured, thus depriving the tendons of their nourishment. Care should be taken not to injure the parietal and visceral layers which become continuous at their proximal and distal extremities. "As the tendon moves the movement is between the serous surface of the layers and there is sufficient redundancy of these '1' . . .

extremity to allow telescoping in at one end and out at the other or vice-versa."

### III. RELATION OF THE VESSELS AND NERVES AND THE TENDONS IN THE FOOT TO THE FASCIAL SPACES AND THE RELATION OF ONE FASCIAL SPACE OR SHEATH TO ANOTHER

The plantar vessels and nerves are in the medial leg space, and in the sole of the foot they are still in it, and deep to the fascial floor of the medial plantar space. The medial plantar nerve passes towards the medial plantar septum and courses forward along it anteriorly. It divides into two branches about 2 or 3 centimeters from the calcaneus. The medial branch becomes the digital branch to the inner side of the great toe passing round the adductor hallucis and coursing superficial to it. The inner branch bulges into M-I but is separated from it by the fascial septum. It passes round the border of the flexor digitorum brevis and enters the M-I space. In the space it divides into the three common digital branches. It emerges from M-I deriving a fascial sheath from its floor and enters the interdigital subcutaneous space.

The medial plantar artery and its vena comitans accompany the nerve, dividing into branches and following the same course as the nerve. The common digital branches anastomose with the plantar metatarsal branches from the plantar arch which become superficial in the subcutaneous interce at the level of the neck of the metatarsal bones.

The lateral plantar vessels and nerves pass through the medial plantar septum into the M-II space and course anteriorly and outwards above the space deep to the fascia covering the quadratus plantae muscle. A branch is given off by the medial plantar artery in this part of its course which in turn passes through the lateral septum. The main trunk of the artery itself pierces the lateral septum at a point midway between the medial tubercle of the calcaneus and the base of the fifth metatarsal bone.

It then passes between that septum (lateral to it) and the sheath of the adductor digiti quinti. There it gives a branch which passes into the lateral space. Again, about 2.5 cms. proximal to the base of the fifth metatarsal bones, it pierces the septum and passes into the M-III space across the interossei. As it reaches the lateral border of the adductor hallucis obliquus it passes deep to it forming the plantar arch. It gives off its metatarsal branches in M-III and it gives a branch to the lateral side of the little toe. The vena comitans follow the artery and its branches. The lateral plantar nerve accompanies the artery and pierces the lateral plantar septum distally to where the vessels pierce it. Opposite the base of the fifth metatarsal bone it divides into a superficial and a deep branch. The latter accompanies the vessel and forms an arch as it comes into M-III and deep to M-IV. The superficial branch divides into an outer branch to supply the outer border of the little toe and an inner which winds round the lateral border of the flexor digitorum brevis and gains access into M-I. From there it enters the interdigital subcutaneous cellular space as the other three from the medial plantar.

The long flexor tendon of the toes and that of the hallux cross one over the other over the tarsal bones proximal to the base of the first metatarsal bone and enter M-II passing through the medial septum. The septum is adherent firmly to the sheaths of these tendons. However that is a weak area there.

Thus it will be appreciated that the tendons and the vessels and nerves by their passage through the septa make it possible for the medial leg space to be in communication with M-I and M-II. The interdigital subcutaneous interspace lodges the digital sheath and the lumbrical. So this space communicates with M-I along the common digital nerves, with M-II along the lumbricals and with M-III deep to the lumbrical space through the loose areolar tissue and along the metatarsal branches of the plantar arch. The lumbricals bring M-II



into communication with the dorsal subcutaneous space. Unlike in the hand, there is no plantar interosseous or thick fascial layer covering the interossei. Hence M-III and M-IV communicate with the dorsal sub-aponeurotic space—particularly facilitated by the dipping in of the terminal branch of the dorsalis pedis artery into the sole which goes to complete the plantar arch. The M-IV space is virtually in the M-III space in its anterior and medial portion so much as to say that M-III potentially extends deep to the fascial floor of M-IV in its entirety. The lateral leg space can communicate with M-III through the passage of the long peroneus into the sole of the foot across the floor of M-III. So also the medial leg space can communicate with M-IV and M-III along the posterior tibial tendon through its fasciculi gaining insertions into the various tarsal and metatarsal bones.

The lateral and medial plantar septa form the common boundary, laterally and medially, of M-I, M-II and M-III and medially only of M-IV. These spaces are between the layers of the muscles and are limited by their fascial sheaths. These sheaths fuse with these septa on either side. So any collection in these spaces if not let out will easily gain entrance into the other ones below and above. Thus the M-II and M-III spaces communicate very easily, M-III with M-II and *vice versa*. The contents in M-I do not so easily communicate with the M-II space or superficially burst out, but find easy escape into the subcutaneous interdigital space. Once an infection gets into this space or starts there it will spread into all the three spaces, M-I, M-II and M-III. If the lumbrical spaces are involved invariably the dorsal subcutaneous spaces in the dorsum of the webs will also be involved. The oedema in the dorsum will be considerable.

The sheaths of the long flexor tendons behind the medial malleolus are in relation to the medial leg space. The sheath of the flexor hallucis longus in this connection is deep to the medial plantar space and medial to M-II and M-III. The common paroneal

sheath is in relation to the lateral space. The sheath of the peroneus longus in the sole comes into relation with M-III.

The lumbrical grooves are to the medial side of the digital sheaths of the outer four flexors tendons. The digital vessels with a separate sheath of fascia are superficial to the digital sheaths and the lumbrical grooves and between them, however separated from them by a fairly fixed layer of fascia. M-II is traceable along each digital slip in connection with the outer four toes.

The extensor tendon sheaths are in the sub-aponeurotic space over the dorsum of the foot.

#### IV. INJECTION EXPERIMENTS

The material used for injection purposes was plaster of Paris mixed with glycerine and water and made into a thin paste. The admixture of glycerine helps slow setting of the plaster and facilitates injection with

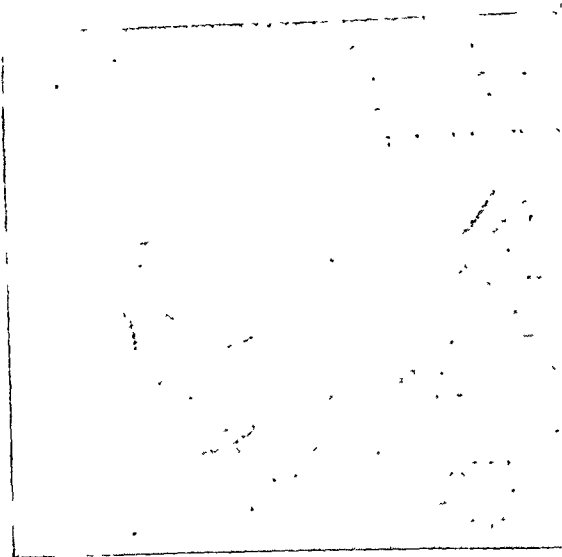


Fig. 15.

the syringe. The mixture was injected into the various spaces using a glass syringe and a needle of wide bore. The plaster was allowed to set and an x-ray taken to define the limits of the spaces in the skiagram. Next, dissection was carried out to demons-

trate the location of the mass in the space injected. Following, a photograph was taken to show the space and its relation-



Fig. 16.

ships. The respective skiagram, clinical photo of the space and an explanatory or diagrammatic sketch have been given wherever possible in the description given above of each space.

Figure No. 15 and 17: X-ray reveals the median plantar space M-I smaller in size than what the actual dissection would show.



Fig. 17.

This is due to the fact that the fascia of the floor and of the roof of M-I are adherent in the proximal part and the material does not



Fig. 18.

easily spread to occupy the entire potential space. So, for practical purposes, it may be understood that unless some amount of tissue destruction occurs, the entire space does not get filled up by the inflammatory exudate.



Fig. 19.

Figure No. 16 and 23 show the lateral view of the foot after injecting plaster of paris into the median plantar spaces. On dissection it was identified to be in the M-II

and M-III and M-IV spaces. The depths of the M-II space from the second may be appreciated from the x-ray.

Figure No. 18 shows oblique view of the left foot with plaster of paris in the M-II space only. This was verified by the dissection.

Figure No. 19 shows plaster of paris in M-IV and also in M-II and M-III. However, the M-IV space is very well defined in the x-ray. It conforms to the lie of the adductor oblique.

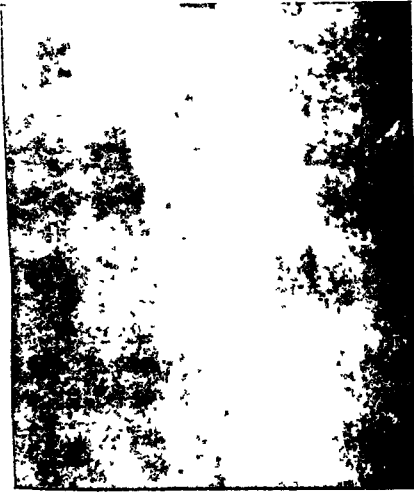


Fig. 20.

Figures No. 20, 21 and 22, show the lateral plantar space, deep to the adductor digiti quinti muscle. The same figures 20 and 21 also show an opacity conforming to the space beneath the flexor hallucis brevis identified by dissection. This space has not been described previously. It lies between the deeper aspect of the flexor hallucis brevis and its fascial sheath. It conforms itself to the extent of the muscle.

Figure No. 22 shows plaster of paris in medial plantar space. The opacity is limited in the x-ray proximal to the base of the first metatarsal. The muscle becomes partly tendinous at the level of the base of the first metatarsal and perhaps gets pressed, as it were, over it. That may be the reason why free spread forwards of the injected—

material beyond the base of the first metatarsal bone does not occur. Similarly it may be noted that the plaster of paris does not spread beyond the base of the fifth metatarsal when it was injected to define the lateral plantar space due to the adductor digiti quinti getting pressed upon the base of the fifth metatarsal bone. However, this may be peculiar to the preserved specimens

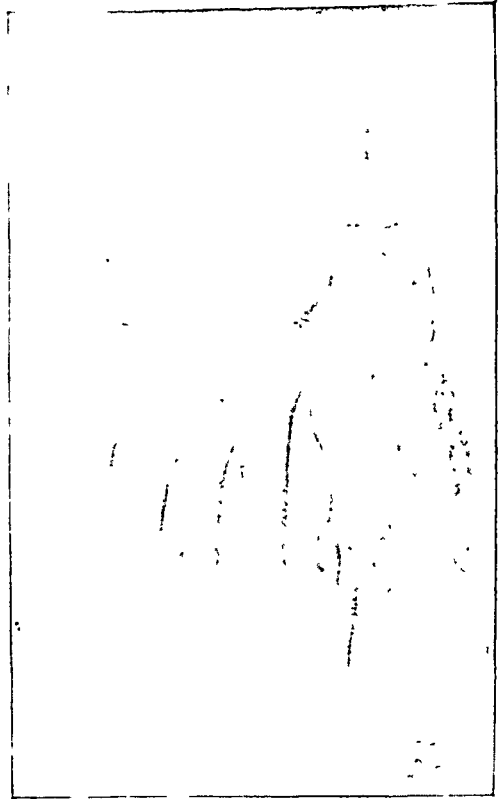


Fig. 21.

as they do not have the suppleness of the living tissues; but some more limbs have to be injected and pictures taken before anything definite can be concluded.

Figure No. 22 shows the inter digital subcutaneous spaces through which pass the digital vessels and nerves with the lumbrical muscle and its sheath in the depths of the space. (Definition not clear in the print.)

Fig. 16, 18, 23. *Subcutaneous tissue space in the heel*: The needle was inserted into

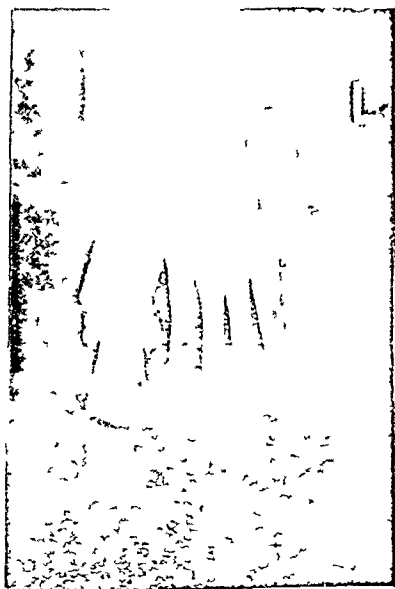


Fig. 22.

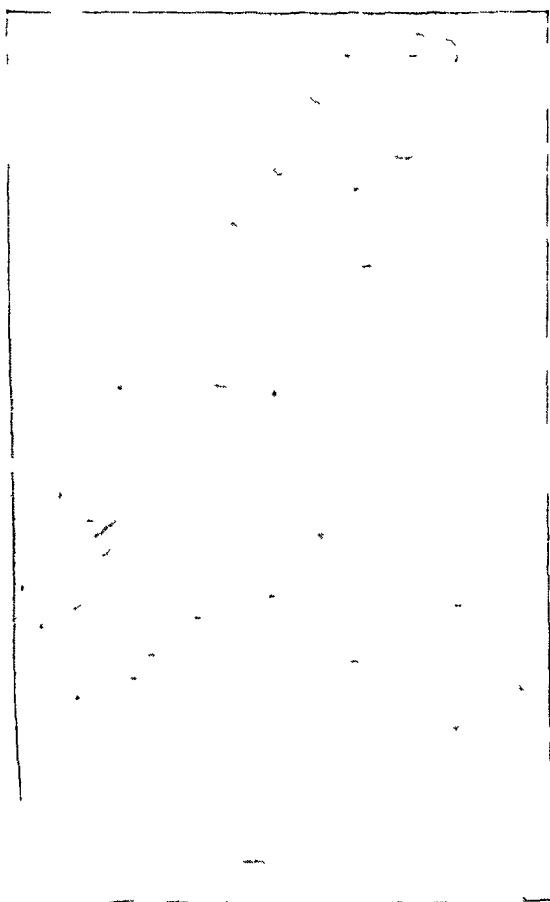


Fig. 23.

the central part of the heel and the fluid injected into the subcutaneous tissue. The fluid went in under great pressure and in jerks, a small quantity at a time suggesting that some resistance is suddenly being overcome. The fluid escapes into a fresh small area every time.

It was noted while dissecting the foot that the thick pad of subcutaneous fat in the heel is granular in structure, being lodged in the mesh work of strongly inter-woven fasciculi extending from the under surface of the thick skin to the deep fascia.

The x-ray shows in the lateral view (Fig. No. 23, 16, 18.) the plaster mass deep to the skin and superficial to and separated from the calcaneus. Note the beaded condition of the injected mass and the antero-posterior extent of it.

Grodinsky has described in detail how the injected mass spreads after bursting through the spaces and sheaths, thus throwing more light on the modes of spread of infection from one space or sheath to another. This part of the experimental work however has not yet been done. When special facilities are accorded for a thorough and more detailed study on a larger scale these anatomical and experimental observations will be correlated with the clinical picture, and the postmortem findings as well wherever possible. A scheme has been drawn up and sent to concerned authorities for approval for further prosecution of this work.

## V. INCISIONS FOR DRAINING FASCIAL SPACES AND TENDON SHEATHS

(a) *Fascial Spaces*—M-I—Incision has to be on the plantar side. But it is disadvantageous in the sense that the sensitive scar is subject to pressure on walking. If the incision is made on the medial side in the middle portion where it does not rest on the ground and if the space is drained through that incision it would be less painful. One has to remember the various septa that divide the space into compartments and has to break them to effect thorough drainage.

**M-II**—Central or median plantar is inadvisable as it develops a painful scar. Moreover, the space can be reached only by going through the flexor digitorum brevis with the result that the drainage will be poor, and later there is a possibility of loss of function.

**M-III and M-IV**—The same objection as observed in connection with M-II holds good. It is better to approach M-II, M-III and M-IV from the medial sides of the foot. "An incision may be made along the medial border of the foot and a haemostat passed deep to the adductor hallucis and flexor hallucis brevis to reach the medial connective tissue septum; depending upon the space infected, the haemostat can be directed through the septum into the particular space involved and drainage effected. This has another advantage because through the same incision any one or all of the three spaces can be drained." It may be remembered that if infection gets in any one of these three spaces, it is almost certain to involve the other two.

**Lumbrical Spaces**—Just as in the hand, the incision should extend from the medial side of the proximal phalanx to the proximal end of the space concerned. If there is extension into the dorsal subcutaneous space, the incision should be extended dorsally from its distal end. As most of the lumbrical space infections are accompanied by involvement of the median plantar spaces it may be necessary to open the latter from the proximal end of the lumbrical incision. However, it will be ideal to institute drainage of these spaces separately from the medial side.

**The medial and lateral spaces.**—These are approached with convenience through their medial and lateral walls.

**Dorsal sub-aponeurotic infections** are fairly localised, and can be opened dorsally by vertical incisions taking care not to injure the vessels and the tendons. If it is secondary to infection in M-III and M-IV, those spaces are to be opened first.

**Dorsal sub-cutaneous space.**—Once the infection localises, the area can be incised

and drained at its most dependant part because it is a superficial space.

**Deep Spaces of the Leg.**—The medial leg space is approached by making an incision on the medial side of the Tendo-Achillis and the incision may be extended proximally to facilitate drainage. The lateral leg space in connection with the peroneal tendon can be opened through an incision placed above and behind the lateral malleolus and extending it proximally or distally as indicated.

**(b) Tendon Sheaths.**—"Two facts are to be considered in the surgical treatment of tendon sheaths infection

(i) Drainage of the involved sheaths, and

(ii) Drainage of any fascial sheath which may be secondarily affected."

The digital sheaths should be opened following the same principle as laid down by Kanavel in draining the digital sheaths of the hand.

The long flexor tendons should be approached from behind the medial malleolus. A small incision is made over the point of greatest localisation in order to identify the sheath. Then the sheath is followed down to its whole length—a probe being used as a guide. It will be necessary to cut the annular ligament which would otherwise interfere with effective drainage. The posterior tibial vessels and nerves are to be identified and taken care of particularly while incising into the sheath of the flexor hallucis longus.

To drain the common peroneal tendon sheaths, the incision is placed directly over it just behind the lateral malleolus. The peroneal retinaculum should be cut to effect efficient drainage. The peroneal artery just behind the sheath is to be cared for while incising it.

**Peroneal Plantar Sheaths.**—The proximal end is explored and a haemostat introduced and opened. This prevents opening through all layers of muscles resulting in poor drainage and a painful plantar scar.

The sheath of the extensor tendons may be opened by placing an incision directly over them and extending the incision over the entire length of the sheath involved. This is facilitated by virtue of their being situated superficially. The anterior annular ligament also has to be cut in this connection.

These various incisions and the advantages thereof have to a great extent been described by Grodinsky.

## VI. COMPARISON OF THE FASCIAL SPACES BETWEEN THE HAND AND THE FOOT

Though there is much in common structurally between the hand and the foot, functionally there is lot of contrast between them. The fascial spaces only are compared and contrasted here in this chapter.

A. Medial plantar space M-III lies deep to the flexor digitorum longus tendons and the *accessories muscle*, while the tarsal bones and the ligaments, the tendon of the peroneus longus, a part of the oblique head of adductor hallucis and the plantar and dorsal interossei form the floor of it. The intermuscular septum projecting down from the medial borders of the central part of the plantar aponeurosis bounds the space medially. This can be compared with the mid-palmar space in the hand. That space also is behind the flexor tendons and lies upon the metacarpals and the interossei separated from them by a thin layer of fascia; but there is one difference. The oblique head of the adductor pollicis does not form the deep relation to the mid-palmar space, whereas a part of the oblique head of adductor hallucis is in the floor M-III.

B. In the hand the thenar space is mainly superficial to the transverse head of the adductor pollicis and partly to its oblique head. Whereas in the foot the transverse head of the adductor hallucis is thin and weak; it lies across the heads of the second, third and fourth metatarsals. The flexor tendons to the index finger and the palmar aponeurosis are superficial to the thenar

space. In the foot, the flexor tendons to the second toe and the plantar aponeurosis are no doubt superficial to the adductor hallucis though to its oblique head. The space between these structures forms a part of M-III only. Thus we see that the spaces corresponding to the thenar and mid-palmar spaces in the hand are not different and distinct in the foot. They are part of the same space M-III.

C. The medial plantar space M-IV is deep to the oblique head of the adductor hallucis where the interossei and metatarsals form its floor. The corresponding space deep to the adductor obliquus in the palm is indistinct.

D. The 'pretendinous mid-palmar space' described by Iselin is bounded superficially by the central part of the palmar aponeurosis with the skin and superficial fascia, and deeply by the flexor tendons and their sheaths, the ulnar bursa. The M-I space is deep to the central part of the plantar aponeurosis with the flexor digitorum brevis and its tendinous divisions, and the tendons of the flexor digitorum longus as its deep relations. Thus M-I corresponds to the 'pretendinous mid-palmar space.'

E. The ulnar bursa contains the tendons of both the flexor digitorum sublimis and profundus. The pretendinous and post tendinous portions of the mid-palmar space are superficial and deep to it. Corresponding in the foot between M-I and M-III lies M-II. The ulnar bursa in its situation can therefore be compared with M-II but with one difference that M-II is a fascial space and the ulnar bursa a tendinous sheath.

F. The medial plantar space deep to the adductor hallucis corresponds to the intermuscular spaces of the thenar eminence of which the adductor pollicis forms a component. Though the medial plantar space is well defined and important in the foot the corresponding ones in the hand are unimportant.

G. The hypothenar area corresponds to the lateral part of the sole of the foot. Deep to the adductor digiti quinti is the lateral

plantar space — corresponding hypothenar space in the palm is unimportant and not distinct.

H. The lumbrical spaces of the foot correspond to those in the hand.

I. The sub-cutaneous and the sub-aponeurotic spaces in the dorsum of the foot correspond to the similar spaces in the hand.

J. The Paronäs' space is a retroflexor space. The fascial space in the medial aspect of the leg and ankle in connection with the flexor tendons and muscles is behind them, between them and the bone below. Thus this part of the medial leg space corresponds to the Paronäs' space in the forearm and wrist.

## VII. THE ANATOMY OF THE LYMPHATICS OF THE LOWER EXTREMITY

"The *Lymph Vessels* of the lower extremity consist of two sets, superficial and deep and their distribution corresponds closely with the veins.

"The *Superficial Lymphatic Vessels* lie in the superficial fascia and are divisible into two groups; a medial which follows the course of the great saphanous vein; and a lateral which accompanies the small saphanous vein. The vessels of the medial group are larger and more numerous than those of the lateral group and commence on the tibial side and the dorsum of the foot. They ascend in front of and behind the medial malleolus, run up the leg with the great saphanous vein and end in the superficial

sub-inguinal lymph glands. The vessels of the lateral group arise from the outer side of the foot. Some ascend in front of the leg and cross the tibia below the knee to join the lymphatics on the medial side of the thigh. Others pass, behind the lateral malleolus, accompany the small saphanous vein and enter the popliteal lymph glands.

"The *Deep Lymphatic Vessels* are few in number and accompany the deep blood vessels. In the leg they consist of three sets— anterior tibial, posterior tibial, and peroneal which accompany the corresponding blood vessels. They enter the popliteal lymph glands.

"Just as in the hand the superficial lymphatic vessels in the foot all converge to the dorsum of the foot by the shortest route. Those in the plantar surface of the foot over the region of the neck and head of the metatarsals reach the dorsum through the webs of the toes. Thus accompanying any lesions at this region the inflammatory oedema shows itself readily in the dorsum of the foot. In any lesion in the heel or along the margins of the foot, the dorsum of the foot shows lymphatic oedema; where there is a lesion in the outer border of the foot or ankle, the popliteal glands swell up and exhibit signs of regional adenitis whereas in connection with the other areas of the foot and ankle the superficial sub-inguinal glands are involved. If the lesion is deep-seated the popliteal glands invariably show evidences of adenitis."

—(From "Gray's Anatomy")

Figures 2, 4, 6, 8, 10, 11, 12, 13, 14 adapted from Grodinsky's papers.

(To be Concluded)

## SENILE ENLARGEMENT OF THE PROSTATE\*

by S. R. MOOLGAVKAR, F.R.C.S.—Bombay.

The prostate is a male sex gland which surrounds the commencement of the urethra. It is pyramidal in shape and is about an inch and a quarter long, by an inch broad and three quarters of an inch thick. It develops as five lobes, anterior, posterior, two lateral and a middle. (Fig. 1). The anterior lobe disappears during fetal life. The posterior disappears soon after birth.

the urethra anteriorly, a small ridge is seen on the posterior wall surmounted by a depression. The prominence is called the verumontanum and the depression is called the utricle. This latter corresponds to the uterus in the female. On either side of the utricle or just within it are two openings, the opening of the ejaculatory ducts. These ducts traverse the prostate in order to reach these openings. On either side and

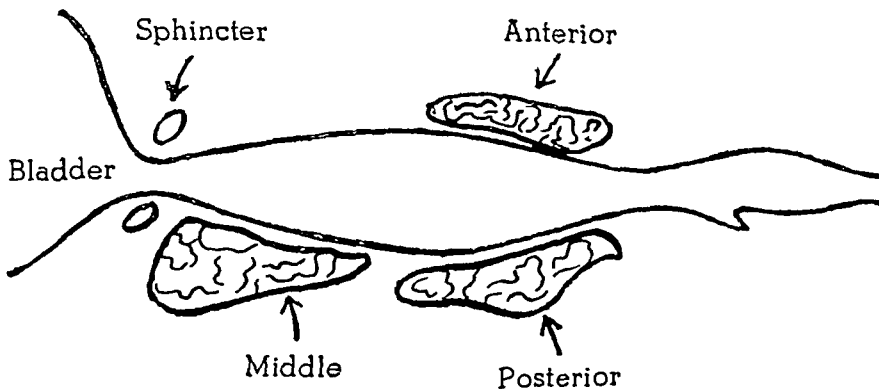


Fig. 1 (After Lowsley)

The middle lobe persists as modified glands behind the verumontanum. The lateral lobes persist and form the two lobes of the normal prostate. These are contained in a capsule. Both lobes are enclosed in a sheath derived from the pelvic fascia. On the deep aspect of the sheath is a rich venous plexus. The apex of the prostate rests against the urogenital diaphragm. The base is applied to the bladder and lies below the internal sphincter. The posterior surface lies in contact with the rectum and is separated from it by a dense fascia—the fascia of Denonvilliers. The anterior surface lies against the cave of Retzius.

The prostatic portion of the urethra traverses the prostate from above downwards and forwards. It lies nearer the posterior than the anterior surface. On laying open

behind the verumontanum are numerous little openings, the openings of the prostatic glands. If a coronal section of the prostate is made, the urethra shows as a transverse slit but in the region of the verumontanum it appears as a demilune with the concavity backwards.

Microscopically the prostate is made up of glands, 20-30 in either lobe and about 15-20 smaller ones behind the verumontanum. These glands are supported by a fibromuscular stroma, the involuntary muscle being very conspicuous.

The function of the prostate is not very obvious though it is quite certain that during the sexual orgasm the involuntary muscular fibres contract vigorously and

\*A paper read in opening a discussion at the 7th annual meeting of the Association of Surgeons of India.



empty out the secretion of the prostatic glands. This secretion is whitish, thin and opalescent. On prostatic massage one can sometimes express small angulated, pale yellowish sago like bodies. These are called *corpora amylacea* and are probably pathological.

The semen as it is stored in the vesicles is lumpy as can be seen immediately after ejaculation and on massage of the vesicles. The prostatic secretion is supposed to liquefy the lumps and liberate the spermatozoa so that they are free to perform their mission. On the other hand there is a view that the prostatic secretion causes clotting of the semen thus preventing the semen running out of the female passages too quickly. I am more inclined to the former view, because in specimens of semen brought soon after emission, for examination in cases of sterility, the semen is found to be quite liquid. The prostate probably has also an internal secretion which increases the sexual urge.

The prostatic urethra is very sensitive. In cases of acute gonorrhoea when the infection spreads from the anterior to the posterior urethra, it is heralded by an increased frequency of micturition. When a bougie is passed into the urethra, the patient feels it most when passing along the prostatic urethra. The sexual ecstasy or libido probably has its origin here.

The act of micturition has not yet been completely and fully explained. It has been held that when the bladder is full, it contracts under volition and the internal and external sphincters being relaxed at the same time are forced open by the increased

intracystic pressure. This is very simple but unfortunately when we come to apply this explanation to pathological conditions we find that this view is not quite adequate. In enlargement of the prostate the residual urine is a constant sign. When I was a student we were told that residual urine was contained in the post-prostatic pouch, as if the post-prostatic pouch were something like a cigarette tin and not constituted in the greater part by living contractile tissue. Besides, the residual urine does reach amounts which can never be accommodated in the deepest post-prostatic pouch. Of all the explanations so far brought forward, that advanced by Young is the most useful. He draws attention to the fact that there is a triangular sheet of muscle under the trigone of the bladder, attached above to the ureteric orifices and to the interureteric bar, and below to the verumontanum. He further points out that the urethra and the base of the bladder form a slight angle with its concavity backwards. (Fig. 2-A.). He maintains that during micturition coincident with the contraction of the musculature of the bladder and loss of tone in the int. sphincter, the trigonal muscle contracts and pulls open the internal meatus. In other words instead of it being just a passive relaxations of the int. sphincter and pressure within the bladder forcing it open passively, the internal meatus is actively pulled open by the trigonal muscle. During cystoscopy it sometimes happens that an irritable bladder goes into a spasm and empties itself by the side of the cystoscope. Under these circumstances if you happen to be observing the base of the bladder you often see the posterior end of the verumontanum drawn

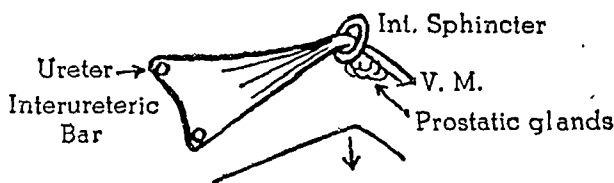


Fig. 2-A ( After Young )

up towards the bladder. I really do not care two hoots how the bladder is emptied but this explanation by Young helps us to understand some of the signs and symptoms of the enlarged prostate. As the prostate gets bigger the internal meatus gets less and less pliant a flow of urine. We have here an explanation of "Hesitation," which is an early symptom of an enlarged prostate. (Fig. 2-B.). It is obvious that if the flow is initiated by pulling open of

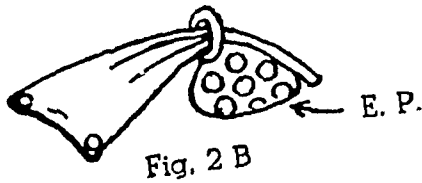


Fig. 2 B

the int. sphincter, the flow will be maintained by the continued action of that muscle. In an enlarged prostate, the trigonal muscle has first to overcome the resistance caused by the additional prostatic tissue and then to maintain the internal meatus open. This evidently will require greater effort. Moreover the muscle is in a stretched and therefore weakened condition. As the bladder empties there is a gradual approximation of the two ends of the tri-

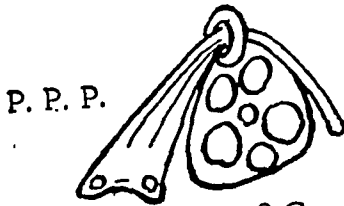


Fig. 2 C

gonal muscle, till a point is reached when the muscle can no longer hold open the stiffened int. meatus. It follows that the greater the enlargement, the greater the resistance to the muscle and the sooner the int. meatus will close, even though the bladder may yet contain urine. We have here an explanation of the gradually increasing residual urine. (Fig. 2-C.).

Senile enlargement of the prostate is, as its name testifies, a disease of advanced

age. Regarding its causation we really know nothing definite.

It was suggested that this disease is part of a degenerative process incidental to advanced age, like arteriosclerosis. This view is absolutely untenable because in arteriosclerotic changes fibrosis is the usual change, whereas in the disease under consideration there is enlargement.

Chronic inflammatory changes were supposed by some to lead to enlarged prostate. Here again fibrosis is more likely rather than enlargement. One of my old teachers used to assert that enlarged prostate is very unlikely in men who have suffered from a stricture of the urethra. I must say I have not yet come across a case where these two diseases were coincident. I should like to know whether my colleagues here have a similar experience.

Enlargement of the prostate occurs at an age when the sexual powers are diminishing. The prostate is a sexual gland and the gland enlarges probably as a result of a diminished sexual internal secretion at an advanced age. Castration at an early age on the other hand leads to decrease in size of the prostate glands. Injection of testicular extract restores them to an apparently normal condition.

Formerly this disease used to be called "Hypertrophy of the prostate." This is evidently a misnomer as the enlargement is not of the nature of a hypertrophy, wherein all the tissues participate, but is more an adenomatous change. If at all, it corresponds more to the chronic mastitis seen at the menopause or to a goitre due to deficiency of Iodine. It is quite true that we do not definitely know what exactly causes the adenomatous change in the prostate. Looking in reverse we can say that it is lack of testicular secretion because we find that there is some relief of symptoms on injection of testicular hormone which is derived, according to some, from the interstitial cells of Sertoli and, according to others, from spermatogonia. Before the days of hormone therapy, vasectomy was

done to relieve this condition without exactly knowing why it did so. From the days of Steinach we know that vasectomy leads to a temporary increase of internal testicular secretion. Diminution of testicular secretion alone could not be the sole cause because if that were so, injections of the testicular hormone should cure this condition, but we find that this is not so. There must, therefore, be something more involved in the genesis of this condition. For some time now I have had an idea recurring in my mind and this was particularly after one had often noticed the marvellous improvement in many cases of cancer of the prostate after injections of Stilbcestron, together with moderate improvement that follows the injection of testicular hormone in senile enlargement. The idea is that in the human male both these hormones exist and that they are correctly balanced by some factor, which we do not definitely know. When the male hormone diminishes there is senile enlargement and when the female hormone falls short there is cancer. By supplementing the hormones we can produce improvement but because we cannot affect the controlling factor the benefits are not curative.

As the prostate enlarges, the lateral lobes participate most. The middle lobe enlarges only in a small number of cases. During enlargement the sheath is put under tension, but yields gradually to the increased tension within; the tension within, however, never completely disappears. The apex of the prostate is resting against the urogenital diaphragm, a tough structure which does not allow any enlargement to proceed in that direction. The base is applied to the bladder and in this direction enlargement can occur more freely. The prostate therefore can enlarge in a longitudinal direction more freely and we find that this is so. The urethra being enclosed within and attached to the prostate participates in this increase in length. Freyer has recorded an increase of six inches in the length of the urethra basing this on requiring a 16" introduction of the catheter before reaching the bladder. The longest I

have come across is 14" and here I could feel the prostate quite an inch above the symphysis pubis. The urethra being attached to the prostate, as the prostate enlarges, the urethra also increases in the antero-posterior diameter. Apart from the lengthening and widening of the urethra an angulation also takes place with the concavity of the angle directed forward. This angulation is due to the holding down of the urethra by the ejaculatory ducts, the apex of the angle being at this point. This angulation is sometimes further enhanced when the glands behind the verumontanum, which resemble but are not identical with the prostatic glands, also, participate in the enlargement and form a true middle lobe enlargement. Freyer never admitted the existence of a separate middle lobe enlargement. He maintained that the projection in the bladder was caused by the undue projection of one or the other lateral lobe. Such mediolateral enlargements are often found but there is no doubt that a genuine middle lobe enlargement does occur. Some people explain interruption of the flow of urine in prostatics as caused by the ball-valve action of such a middle lobe. For this to occur the middle lobe enlargement must be freely movable as if on a hinge or on a spring. This is never so. The interruption probably has the same explanation as that occurring with a stone in the bladder, namely, spasm of the int. sphincter. It can quite easily be understood that when angulation is markedly present the passage of an ordinary catheter will be impeded. The coude catheter is very useful here. Even this does not suffice sometimes. In such cases a Harrison stylet threaded into the catheter—always taking care to see that the point of the stylet will not come out of the eye of the catheter, otherwise the urethra will be ploughed up—and then moulded to the necessary curve, is always useful. Sometimes even this is not sufficient and then a finger introduced in the rectum lifting the catheter over the obstruction usually allows the passage of the catheter. There are indeed very few cases which will not yield to this manoeuvre. I am not fond of using metal catheters. If all

these means fail, the only way is either suprapubic puncture or a decompression operation.

While we are on the subject of the middle lobe I may mention that Freyer described what he called a preprostatic pouch, namely the space in front of the middle lobe constituted by the prostatic urethra. He diagnosed it when on introducing a catheter only a small quantity—about an ounce or two—of urine was withdrawn even though the bladder was felt distended above the symphysis, but if after the initial flow ceased the catheter was pushed further in, a large quantity of urine was withdrawn and the bladder emptied. He also claimed to have crushed stones in this situation. I have no experience of this pouch.

Apart from the elongation and angulation, the urethra is compressed laterally by the tension within the sheath of the prostate. Whereas normally the coronal section shows the prostatic urethra as a transverse slit, in enlarged prostate the slit becomes antero-posterior. An unequal enlargement of the two lobes leads to a sinuous or tortuous urethra, with corresponding difficulty in the passage of a catheter.

During enlargement of the prostate there must be increased blood supply; this will be reflected in the urethra as congestion. We find therefore that one of the earliest symptom a patient with enlarged prostate suffers from is burning during micturition. An elderly person without a urethral discharge complaining of burning during micturition should always make us think of an enlarged prostate.

There is usually a congestion of the pelvic viscera in the early hours of the morning as is evidenced by an early morning erection. This congestion superadded to the existing congestion in an enlarging prostate leads to the characteristic early morning frequency of micturition.

In some cases, the increased vascularity together with some personal anatomical anomaly in the patient leading to venous

obstruction, results in the formation of varices. These are most manifest in the least supported part of the prostate, i.e. the internal meatus and the vesical surface. These varices sometimes burst and lead to quite a tidy haemorrhage. It is a noteworthy fact that bleeding is more common with a simple enlargement than with a malignant one.

Another important result of congestion—I should rather say an attack of congestion, the result of a chill or of some indiscretion in diet or sexual life—is retention of urine. A passage which was already partially obstructed as a result of tension within the sheath gets completely obstructed as a result of increased tension due to the attack of congestion. This is one of the symptoms which definitely makes the patient seek help. That the attack of congestion plays an important part in retention there is no doubt because the congestion passes off after a few days and the patient returns to the *status quo ante* retention. I must say here that some observers attribute retention to neuro-muscular action, in other words spasm. I am not inclined to agree with this.

We have already seen the mechanism of residual urine. The residual urine gradually increases and with it also increases the frequency of micturition. The bladder being incompletely emptied gets full enough to excite the micturition reflex sooner and sooner. But it is not all so simple as the example given in most text-books namely that—suppose the capacity of the bladder is 10 ozs., a person to void the normal quantity of urine must micturate five times. Suppose that there is 4 oz. of residual urine, the available capacity is only six ounces and therefore the patient must pass urine 8 times. This is alright as an example but we must not forget that as the residual urine increases the bladder gets stretched and holds more and more urine. This is particularly so when the residual urine approaches and passes the normal capacity of the bladder. Residual urine may reach quite large quantities and yet the patient may not be conscious of it. I have seen distended

bladders the result of residual urine reach up to the umbilicus and yet the patient was not conscious of it beyond a feeling of heaviness and of the abdomen getting bigger. During retention due to enlarged prostate I have seen the bladder reaching between the umbilicus and the xiphisternum. Another notable feature is that with retention, the prostatic does not suffer the same agony that a man with retention due to stricture suffers with a much smaller distended bladder. This is probably due to the bladder having been gradually stretched out in a prostatic as compared with the acute distention and stretching in a stricture. As a result of the constant distention and of repeated efforts at emptying the bladder the longitudinal fibres of the bladder get hypertrophied and

straining forces them together and tends to interrupt the flow. Swift Joly built a hydrostatic theory round this fact. Such prostatics do not strain during micturition. As a result of frequent straining by elderly persons, direct and when there are pre-formed sacs, indirect, herniae occur. Pro-lapse of the rectum and bleeding piles are another result of the same.

The stream of water in a prostatic is usually quite big in contrast to that in a stricture of the urethra. The force and projection however suffer. In the prostatic the main difficulty is in getting the internal meatus open. Once that is open the passage is potentially wide, though by the pressure of the enlarged lobes it is reduced to a mere chink. If the meatus is well opened a fair quantity of urine can flow through but the

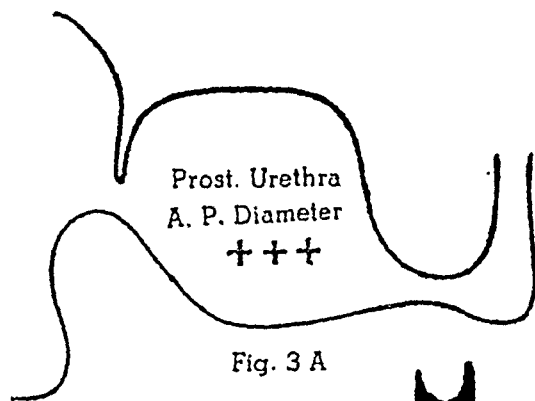


Fig. 3 A

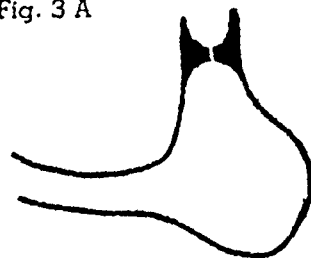
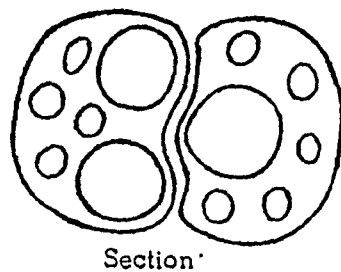


Fig. 3 B



Section

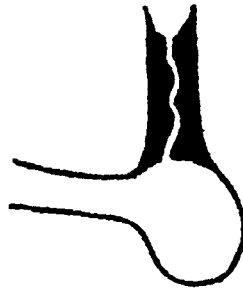


Fig. 3 C

stand out as trabeculae, with recesses between—sometimes of fair size—which are called sacculi.

A prostatic strains during micturition. It sometimes happens that the anatomical configuration of the two lobes is such that

force of the flow is reduced because it is expended in keeping the chink open (Fig. 3-A). In the case of the usual type of annular or diaphragm stricture (Fig. 3-B) however the opening is inflexible and the flow through is comparatively small and

therefore the stream is small, but the force is not diminished to any extent because practically no pressure is expended in keeping the narrowed part open. In cases of tortuous strictures (Fig. 3-C) however, both flow and force are diminished. This occurs also in prostatics when there is considerable pressure within the prostatic sheath as in cases approaching retention.

In marked cases of prostatic obstruction, a largish flow falls straight down from the external meatus. There is often interruption and there is dribbling at the end. In many cases the patient passes a quantity of urine with much straining but does not feel quite satisfied. He tries five or ten minutes afterwards and can pass a fair quantity without much difficulty. Here probably there was marked congestion which caused the initial difficulty but after a portion of the urine had been passed, the congestion diminished a little and the flow was more easy.

As the quantity of residual urine creases and approaches the normal capacity of the bladder, back pressure begins to be felt by the ureters and kidneys. These dilate bilaterally but never to any great extent. The most important effect on the kidneys of the back pressure is interstitial nephritis which gradually cripples the kidneys leading to retention of waste products in the blood and to chronic uraemia.

Infection after instrumentation is quite easy in prostatics. Once infection occurs it gets worse rapidly and is difficult to eradicate because the bladder is never completely empty and the residual urine acts like a seeding medium. Infection superadded to back pressure leads to septic pyelo-nephritis and to rapid destruction of kidney tissues and function.

The main symptoms and signs of enlarged prostate therefore are burning during micturition, hesitation, frequency particularly in the early morning, difficulty in micturition, loss of force in the stream, retention of urine and chronic uremia. To this, signs of septic pyelonephritis may be added.

Harassment by frequent micturition during the day, exhaustion by disturbed sleep by repeated micturition during the night, suffering and anxiety resulting from retention and interstitial nephritis lower the body resistance and make the patient an easy prey to intercurrent disease like pneumonia; septic pyelonephritis often gives the *Coupe de grace*.

When an elderly person comes to us complaining either of burning during micturition or frequency or difficulty we naturally think of an enlarged prostate.

On inquiring into the history, we find that the trouble started insiduously and has progressed gradually. The history most often extends over a year or two. Sometimes it extends over 4-5 years and I had a case which gave a history extending over nearly 20 years. Many of the patients are not observant and take notice only when there is difficulty in micturition. A few wake up only when there is retention. Rarely the first sign is haemorrhage. Most of my cases came during the difficulty period and many only after retention.

The usual questions regarding micturition namely frequency D/N, force, stream, hesitation, interruption, haematuria, passage of gravel and retention are asked. The condition of the tongue is noted.

The abdomen is examined by inspection, palpation and percussion particularly as to the condition of the kidneys and bladder. In prostatics a distended bladder is not an unusual finding without the patient being aware of its existence. The patient should be made to pass urine in your presence to verify some of the answers to the questions asked regarding micturition.

A rectal examination of the prostate is best made with an empty or nearly empty bladder. It is also necessary in cases of enlarged prostate to determine the quantity of the residual urine. Passing a catheter into the bladder opens the gateway to urinary infection. This is much more so in a prostatic. Special precautions should therefore be taken. The foreskin when present should be completely retracted and the

perputial sac well washed. It is surprising how often smegma is allowed to accumulate even in otherwise clean persons. The meatus should be well opened and washed out with a stream of antiseptic solution. Nowadays I use Dettol 1-150 for this purpose. It is needless to say that the surgeon has washed his hands clean. A sterile No. 10-12 catheter is now taken. The lubricant I use is a mixture of vaseline and liquid paraffin of the consistency of honey. This mixture is autoclaved and kept in a glass-stoppered bottle. In order to economise a small quantity is floated on to a quantity of sterile water in a minim glass. The catheter is now dipped into the lubricant and then gently inserted into the urethra and passed into the bladder. The difficulties in connection with this have already been discussed. The urine collected is measured. It must be noted however that in a suspected prostatic whenever there is distention of the bladder unrelieved by micturition, with the bladder extending more than an inch above the symphysis, the bladder should not be emptied completely at once. Under these circumstances the patient should be admitted into a hospital or nursing home and after passing a catheter a stopcock should be fitted to the catheter as soon as it enters the bladder. The catheter is then tied-in. The stopcock is next opened so as to allow the urine to escape drop by drop. It is no use measuring this urine with the idea of determining the residual urine, as the urine is being added to continually by more coming down the ureters. It can obviously be taken for granted that the residual urine is considerable. The object in not emptying the bladder at once under these circumstances is to prevent haemorrhage from the kidneys. The urine which has been dammed up and has been exerting back pressure, when suddenly let out, induces haemorrhage by the sudden withdrawal of the support afforded during months and sometimes years of back pressure. The haemorrhage in itself is not very serious but in advanced cases where naturally the bleeding is more marked, the blood clots within the tubules of the kidney and leads to anuria, uremia and death. Before withdrawal of the catheter

it is my invariable practice to wash out the bladder with Pot. Permanganate 1 2000 when the urine is cloudy and in all cases to instill 10 c.c. of 1 per cent. aqueous acriflavine. Whenever a catheter is tied in, the bladder is washed out daily. In all cases of instrumentation an urinary antiseptic is given, before whenever possible, and always after. I usually prescribe Hexamine grs. vii three times daily.

Once the bladder is empty a rectal examination of the prostate is made. I use the dorsal position with the legs well drawn up and separated. This allows the pulp of the examining finger to come in contact with the prostate comfortably. The finger should be well lubricated. The median groove is noted; then the lateral lobes, their size and consistency. The upper border of the prostate is next defined. Then with the left hand pressing in above the symphysis pubis a bimanual examination is made to determine the mobility of the prostate. The last two points cannot be made out properly if the bladder is distended.

The senile enlarged prostate is usually uniformly enlarged on both sides. The lobes feel elastic and are movable. They are not tender to the touch.

An acutely inflamed prostate may give rise to difficulty in micturition and even to retention but it is a disease more common in younger people, is of acute onset, accompanied by fever and by pain in perineum and rectum. The prostate is enlarged and is acutely tender.

Fibrosis of the prostate occurs often in old people and gives rise to difficulty in micturition and even to retention. It is usually accompanied by arteriosclerosis. The prostate is smaller than normal and is hardish to the feel. It is not so mobile as a normal prostate.

Prostatic calculus may give rise to moderate unilateral enlargement but usually there is no definite increase in size. There is a hardish nodule to be felt in the prostate which is slightly tender to the touch. There is usually some burning during micturition. The X Rays clinch the diagnosis.

The prostate is felt from the vesical side. Sometimes it projects markedly, at other times it is just a firm bulge.

In cases where permanent cystotomy is intended and in those cases where a two stage operation is to be done this is the end of the interference for the time being except that if there are any diverticula these are dealt with now. A three quarter inch inside diameter rubber tube is introduced and the bladder wound approximated round it.

It should have two lateral holes at bottom and the bottom edge should be secured. The tube should not be long enough to touch the base of the bladder as this excites spasmodic contractions on slight movement by the patient and is unnecessary suffering. A gauze drain should be put in the cave of Retzius and the rectus sheath brought together by interrupted catgut. The fat and skin are approximated by silkworm gut stitches. The tube should be anchored by a stitch which divides its lumen one third thirds and is then cut off half an inch above the skin. A few pieces of gauze and copious cotton wool or if obtainable cellulose dressing should be applied and retained by a four tailed bandage. The after care is the same as after a prostatectomy and will be considered there.

The second stage of the prostatectomy should be undertaken within two or at most three weeks after the first stage. If longer time is allowed to elapse the abdominal wall in the region of the cystotomy becomes unyielding and it becomes difficult to depress it sufficiently to ensure easy enucleation of the prostate.

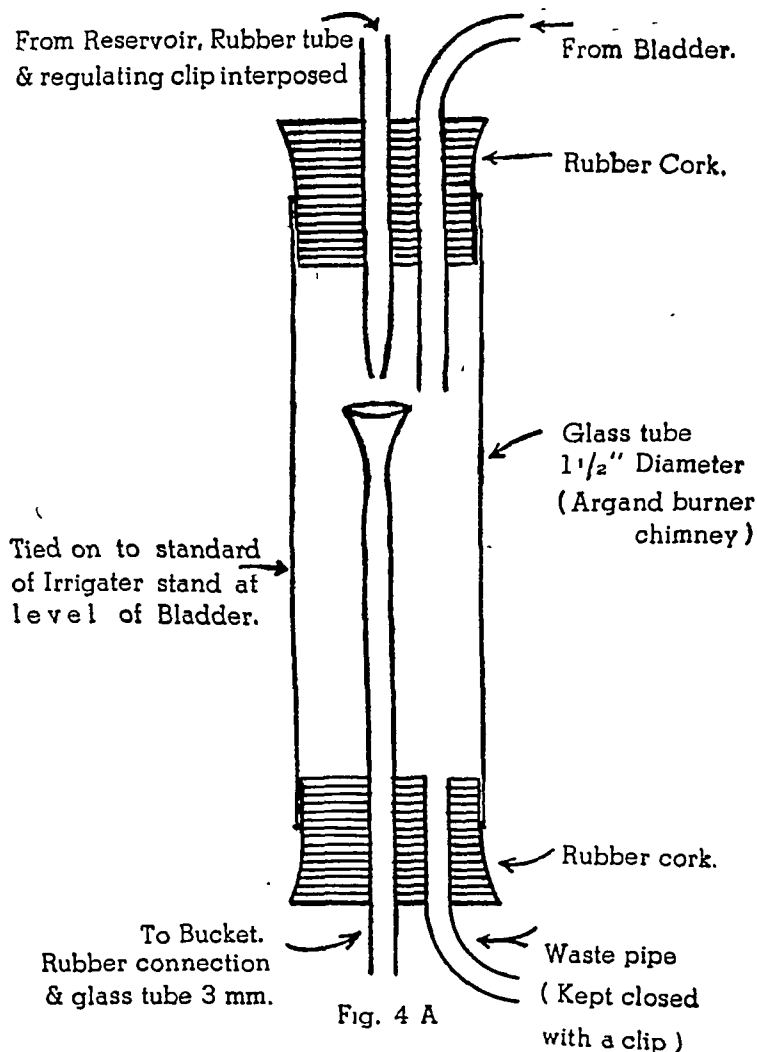
After the usual preliminary preparation, the tube is removed and the bladder washed out well. Incisions in the skin are made to enclose the scar of the first operation. The rectus sheath is opened up and the bladder exposed. Great care is necessary in pushing up the peritoneum as the tissues are now more adherent and more friable. After enlarging the opening in the bladder a sterile towel is laid like a gutter over and between the separated thighs and the gloved

index and middle fingers of the left hand well lubricated are passed into the rectum and by pushing upwards and forwards steady the prostate. The ungloved right index finger is passed into the bladder and the internal meatus is felt. The catheter which is in the urethra should be withdrawn so that it just projects into the bladder. Too much of it in the bladder comes in the way. The tip of the finger is pressed hard against the superior surface of the right lobe of the prostate a good half inch away from the meatus. I have found no necessity to use either scissors or keeping a long nail on my finger. The mucous membrane is felt to give way under the strain and the finger gets on to the prostate. The direction of the pressure is slightly changed from parallel to the urethral axis to slightly outwards. The finger, if in the proper plane passes comparatively easily and is pushed on the lateral aspect of the lobe towards its lower pole. The finger is then withdrawn more than half way and swept anteriorly and posteriorly along the outer aspect of the lobe. This tears the mucous membrane in a semi-circle around the internal meatus. The same sweeps are repeated in stages right down to the lower end of the right



towel. Both hands are rinsed with Dettol and spirit equal parts, dried, dusted and fresh gloves put on. The prostate is now seized by the prostatic forceps and delivered out of the wound. With large prostates this may be difficult and the prostate may have to be delivered lobe by lobe. Occasionally with a small prostate, it slides about in the vesical cavity and causes exasperation.

bleeding practically ceased. Sometimes however the bleeding persists and blood wells out of the wound. The catheter which is still in the urethra is adjusted so that the eye is in the prostatic cavity and is then connected to an irrigator containing 1/2000 silver nitrate in distilled water at about 115°F. About two pints of this fluid are run through keeping the irrigator about one



There has been a certain amount of bleeding during the operation but ordinarily by the time the prostate is delivered outside, the blood has clotted well and the

foot above the pubes. Care should be taken to see that there is free exit for the blood clots and the fluid through the abdominal wound, if not there is distention of the pros-

tatic cavity and more bleeding. At the end of the irrigation the bleeding has ceased in practically all cases. In those very few cases where the bleeding still persists either a Pilcher bag is introduced or the prostatic cavity is plugged with gauze. I used to do the former but nowadays the bags are not available and besides the removal of the bag afterwards is always a painful procedure. Therefore I pack when necessary. The

pleted as for a suprapubic cystotomy, the gauze drain in the space of Retzius not being omitted. A quarter grain of Morphia is injected before the patient is sent back to the wards.

Some patients suffer from shock for which lowering of the head is usually sufficient. If not intravenous plasma meets the needs.

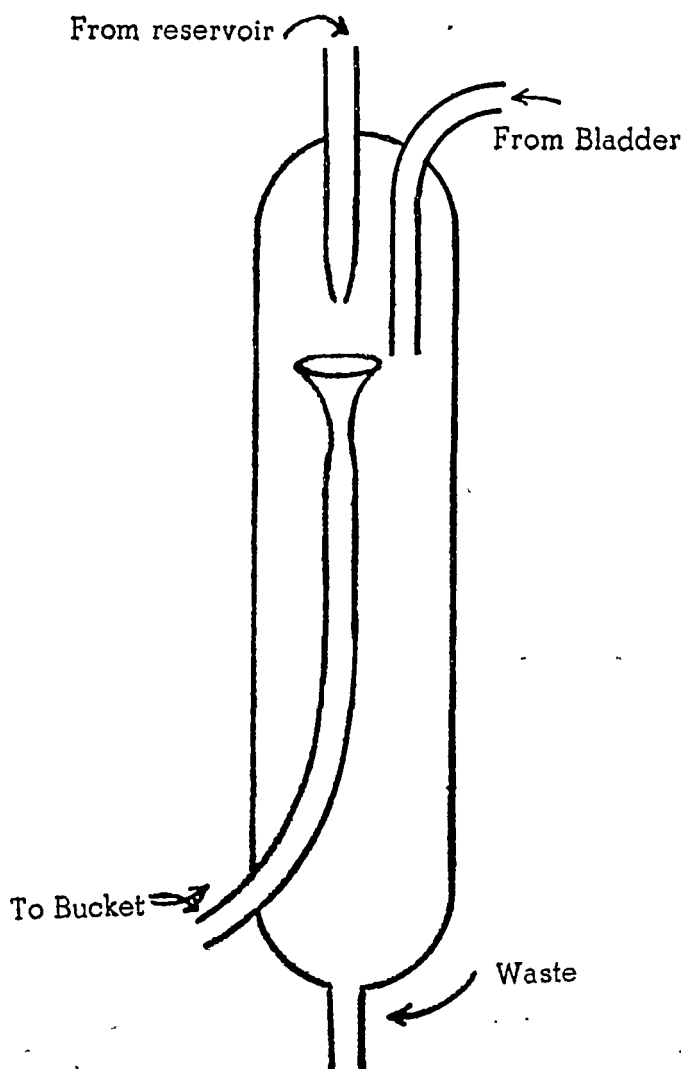


Fig. 4 B

gauze I used to soak in vaseline but now I sprinkle sulphanilamide powder and pack it in. The gauze roll should be about one inch broad by  $\frac{1}{8}$  inch thick. This means about six layers. The operation is now com-

In a few hours the dressings are soaked in blood-stained fluid. So long as the fluid is only bloodstained I do not worry but if clots begin to accumulate, in unpacked cases, over the abdominal wounds I certainly

worry. It means taking the patient down to the operation room, removing the tube and a few stitches and packing the prostatic cavity under anaesthesia. The tube and stitches are replaced afterwards. In moderate bleeding Cal. Gluconate intravenously, Coagulen Ciba, elevation of the foot of the bed, etc., are tried. It is no use wasting time with these if the bleeding is serious and the pulse going up.

After about six hours I put the patient on suction drainage. If dressings only are used they get soaked in no time and the urine gravitates to the sides and wets the bed-sheets and makes the patient very uncomfortable. When I was a House Surgeon at St. Peter's, London, one of the surgeons used to have cellulose dressings only. The patients were very uncomfortable. The other surgeons used to use the Irving's box. This kept the patient reasonably dry provided he did not move much. The disadvantage was that unless properly adjusted it pressed on the wound and was uncomfortable and even painful. It also tended to cause oedema of the wound and delay in healing. For some years now I have been using a simple suction apparatus. It keeps the patient quite dry. He cannot however turn on his side. Herewith is the illustration of the main part namely the pump. The most important part is the central funnel. It helps to form the interrupted column of water which by an action similar to Sprengel's pump keeps the suction going. If a sample of the urine, unmixed with water is required, all that is necessary is to connect a Wolf's bottle between the bladder and the pump. The bladder is irrigated out daily through the tube as well as through a catheter introduced into the prostatic cavity. This latter step is absolutely necessary in cases where sepsis is present. In very bad cases of sepsis I use an automatic irrigator together with the suction, the catheter being kept in the prostatic cavity. In ordinary cases the irrigation is done twice a day. For irrigation I use one volume Hydrogen Peroxide or if that is not available Pot. Permanganate 1/2000.

On the 4th to 6th day I substitute a smaller tube. On the 12th to 14th day the

tube can be dispensed with. I tie in a catheter when I remove the tube. The catheter can be dispensed with in from 5-7 days. All these dates depend on the progress of the wound and of sepsis if present.

In cases of permanent suprapubic cystotomies a self retaining catheter is put in about the 7th day.

The patient is asked to pass urine every two hours or so after the catheter is removed. There is ordinarily no difficulty and there is no leakage from the suprapubic wound. Sometimes a fistula persists and in such cases the catheter is tied in again and the fistula cauterised with silver nitrate fused on to a probe. This usually suffices, but if it does not, scraping with a small spoon should be done. Fistula sometimes persist in spite of all this and here either the bladder has got adherent to the pubis or there is persistent marked sepsis or there is obstruction at the internal meatus. For the first condition opening up the suprapubic wound and liberating the bladder and cutting away as much of the fibrous tissue as possible is necessary. It is because of this that emphasis was laid on having the bladder wound at least three quarters of an inch above the pubis. The second condition is likely to arise from an overlooked diverticulum or from bad cystitis or pyelonephritis. With a catheter tied in they heal, but are apt to break down again and again. Getting the patient up and about sometimes helps in these cases. The last condition is diagnosed by passing a bougie. A mere narrowing is dilated by bougies and MacCarthy's resectotome is used to remove sections of the narrowed opening. In the very rare complete obliteration of the internal meatus a suprapubic approach and a bougie in the urethra—in fact a retrograde catheterization operation for impassable stricture in reverse—is necessary. This condition arises because enucleation is started too close to the internal meatus. It should be started at least half an inch away. It is possible that a fistula may persist because of incomplete removal of the prostatic adenomas.

Amongst all the operations performed for enlarged prostate by me it has been my misfortune to have had three cases of sudden

death, the result apparently of sudden cardiac failure. One was in a two stage case very soon after the patient was discharged. The second was in a case of suprapubic cystotomy in which the patient was not suitable for prostatectomy and the third was in a single stage operation on the seventh day. All these cases were apparently doing well but were dead within a few minutes of the seizure. I do not know what the 1st was doing but the second was sitting up in bed as he was wont to do and the third had just got on to a bedpan. These deaths were a great shock to me and I should like to know if any of my colleagues here have suffered from similar misfortunes.

Amongst later complications hernia of the scar has occurred in five cases. In two the hernia was fair sized. The large tube used probably has something to do with this.

Stones have formed in two cases. There was a history of previous stone formation in one. Both were probably helped by mild sepsis. One was two years and the other four years after operation. The stones were crushed and removed.

The non-operative treatment consisted in the old days in inducing a catheter life. This was before the firm establishment of prostatectomy. The patient was taught to pass the catheter himself. I have seen such patients when I was a House Surgeon at St. Peter's in 1914-15. Considering everything it was miraculous that the patient did not develop cystitis more often.

Cases with retention which are not suitable for the radical operation and which do not respond to the other palliative measures immediately to be described should be recommended to have a permanent suprapubic cystotomy done.

The catheter however has a place in the treatment of enlarged prostate. In case of large residual urines and in cases who come to you with retention, it is best to tie in a catheter. I have here a few models to show the method of tying in a catheter used at St. Peter's. Of all the methods I have

seen it is the best. I always have two holes instead of the usual one in the catheter. One can easily cut a hole on the side opposite to the existing one. If one hole gets blocked by a fold of mucous membrane or by mucopus, the other is there. Before tying the tape the best position is found by withdrawing and pushing in the catheter. The aim is not to get a sudden gush but to get a steady constant drip. When this is found the first tape is tied just beyond the external meatus. The remaining stages are illustrated in the models. The bladder should be irrigated with Pot. Permanganate 1/2000 at least once a day and some urinary anti-septic should be administered. It is surprising how very often the general and urinary condition and the blood picture of the patient improve within a fortnight of tying in the catheter. The catheter should be changed every four days if of gum elastic and a new one put in. In the case of rubber catheters it suffices if they are changed once a week. They can be boiled and used again provided they retain sufficient stiffness.

One of the methods of treatment used was massage of the prostate. Steady but not too vigorous strokes are used. The massage is done twice a week. The rationale is the emptying out of the cystic spaces in the adenomas. The result is to ease micturition. The effect is very temporary and is usable in the earlier stages of enlargement. It can hardly be called treatment.

Whenever some new form of treatment comes in there are always enthusiasts amongst us who will try it out and sometimes convince themselves and often try to convince others that "This is it". When medical electricity came in, galvanic and faradic currents with special electrodes for the prostate were tried out for chronic gonorrhoeal prostatitis. It was also tried for enlarged prostate, needless to say, without any benefit beyond a psychological effect. When diathermy came in, this horse also was run for all it was worth. The fomentation relieved congestion at times with transient beneficial effects. Short wave therapy cannot claim anything better.

Amongst what I may call the mechanical electrical appliances, Bottini, as far back as 1876, invented his prostatic galvano-cautery. This instrument, contained a platinum blade capable of being heated like an ordinary galvano-cautery. This blade could be made to traverse the prostate by means of a screw something like the lithotrite screw. Linear cauterisation of the prostate was carried out. After some days a slough of the burnt tissues was passed out and there was a little relief of symptoms. The gap however soon filled up and the symptoms returned in full. At best it was a blind operation and sometimes lead to bleeding and other accidents. For more than 25 years it had a vogue as is testified by the numerous modifications of the instrument invented, among others, by Young.

The most recent electro-mechanical appliance is MacCarthy's trans-urethral resectotome. The instrument is provided with a telescope and is electrically lighted so that you can see what you are doing. There is also a circulating water medium provided, so that the field is kept clear except in case of much bleeding. The resectotome part is a small loop through which a high frequency cutting current can be passed. This loop together with the light and telescope can be moved through about two inches by means of a rack and pinion outside. By this instrument slivers of the prostate  $1/8''$  to  $1/6''$  thick and about two inches long can be removed. Coagulation current can be superimposed at the same time so that bleeding is reduced to a minimum. I have tried out this instrument in enlarged prostates. The first half a dozen cuts or so are alright but as you go deeper a small vessel starts spouting, in spite of using heavy coagulation current, and no amount of water circulation is capable of keeping the field clear. The seance has got to close. Sitzings can be given at weekly intervals. The instrument is a fair-sized one approaching No. 30 F. The patient must have anaesthesia. Rather than give repeated anaesthetics I would do a prostatectomy in one go. Besides it would not be possible to remove the prostate with this instrument

completely. We cannot therefore classify this method as curative. I have however found it valuable in the shrunken fibrous prostate causing difficulty in micturition. Here a few slices removed from the internal meatus has always given relief. Prostatectomy in these cases of fibrous prostate is an undertaking—I have put in as much as an hour and a half's-strenuous work taking out a prostate an inch by three quarters. It is not worth it. I have used the resectotome since ; it is simpler.

Amongst electrical remedies, X-Rays certainly deserve notice. Those cases which are not suitable for operation or those cases which refuse operation, I refer to the radiologist. The results are not permanent but symptoms are relieved for about 12-18 months. If there is recrudescence, then a further course can be given. Sometimes after the 1st course, as a result of the shrinkage that occurs, the symptoms, the general condition and the blood picture improve so much that an operation can be undertaken. The operation however is always more troublesome because the prostate becomes fibrosed and adherent. The patient should be warned that he must not expect results till four to six weeks have elapsed after the X-Ray treatment.

Radium application has not been such a success. Both Radium itself and Radon have been tried.

Before I turn to the medical aspects of treatment I must mention the prostatic punch. This has no *locus standi* in the treatment of the prostatic, but for a fibrous prostate or for enlarging a narrowed int. meatus it has been used. Personally I have, no experience with it and I should certainly prefer MacCarthy's resectotome for these purposes.

Turning to medical treatment, Ergot and Strychnine, Hyocyanus and Belladonna have no value in the treatment of this condition.

Injections of Carbolic Acid have been tried and like those given elsewhere for other diseases, they induce reaction and fibrosis. They are too uncertain in their

effect and are not to be relied upon. Sometimes they cause severe reactions.

The only injections that have some effect on the prostate are those of the Testicular Hormone. By these injections the enlargement is slowed down, there is sometimes even a temporary regression of symptoms, this latter probably the result of diminished congestion. As an adjunct to X-Ray treatment it is of value in those cases where a radical operation cannot be considered. It should be given in 25 mgm. doses twice a week. As already mentioned vasectomy which had a temporary beneficial effect on enlarged prostate, owed it to extra production of this hormone.

I have records of 154 cases. Some of my records were lost and the earlier ones are meagre in detail.

Of the 154 cases, 5 were between 45-50, 63 were between 50-55, 54 were between 55-60, 29 between 60-70 and 3 above 70. It can be seen that this disease is most common between 50-60.

There were 71 Hindus, 37 Parsis, 17 Mahomedans, 13 Jews, 11 Christians, 1 Armenian and 4 Europeans.

In 26 the symptoms extended for less than 6 months, in 42 between 6 months to a year, in 61 between a year and two, in 13 between two and three years, in 9 between 3-4 years and in 3 for more than four years. Amongst the last was a patient with symptoms extending over 20 years.

Of the 154, 131 were operated on. Twenty-three were not interfered with. Of these, two had less than two ounces of residual urine and nothing was done for them. They were lost sight of.

Sixteen refused operation or were unsuitable for operation and were advised X-Ray. Of these 16, four are alive today, 1-3 years after starting treatment, 6 are dead 1-4 years after starting treatment and six have been lost sight of. Those observed showed improvement after the 1st sitting but the good effect diminished with each succeeding course of X-Rays and the symptoms recurred sooner and sooner.

The other five non-operative cases had repeated retention with septic pyelo-nephritis. They all had clinical symptoms of chronic uraemia and died from a week to four months after tying in the catheter.

Of the 131 operated cases: nine were permanent cystotomies because of very poor kidney function. Of these nine, one died suddenly of cardiac failure on the eve of his discharge from the nursing home. Three others died one to four years after operation. One improved so much that he had a successful prostatectomy done by another surgeon. I have no news of the remaining four.

Of the remaining 122, 96 were two-stage and 26 one-stage operations.

Of the 96 two-stage operations, the 2nd stage was carried out in 10 days after the first in seven cases, within fourteen days in 81 cases, within three weeks in 5 cases, in four weeks in two and after six weeks in one case. The usual time is two weeks. The delay was caused by marked sepsis in six cases, bronchitis in three cases and pneumonia in one case. One case died suddenly two months after discharge. The operative mortality (in the Hospital) was twelve deaths or 12.5 per cent. The causes of the death varied but the most common were uraemia and pneumonia. Since the introduction of the sulpha drugs we have more control over sepsis and pneumonia and I feel sure that Penicillin will help us save some more patients. Of these twelve deaths 9 were during the 1st stage and three during the 2nd. It must not be forgotten that many of these cases were on the border line of bad risk.

Of the 26 one stage operations; there was one death by sudden cardiac failure on the 7th day and one by pneumonia, a mortality of 7.7 per cent. The sudden cardiac failure has sent up the mortality rate in otherwise selected cases. The pneumonia death was before the sulpha drugs came in.

Of the 154 cases no less than 56 or 36.4 per cent were seen by me first during retention. 91 or 59.1 per cent came during the stage of difficulty. Only seven cases came

during the stage of burning or hesitation. Of these, five had  $5\frac{1}{2}$ ,  $6\frac{1}{2}$ , 7, 9, and 11 ozs. residual urine. The remaining two had less than two ounces, though the prostate felt definitely enlarged. No cystoscopy was done in these two cases.

Cystoscopy was done in 86 cases.

When first seen 79 cases had pus in the urine. In 17 cases the urine was faintly opalescent, in 46 opalescent and in 16 cases it was quite turbid.

Eleven cases gave a history of previous haematuria.

Five cases gave a history of gravel or a previous operation for stone. In twenty-nine cases stones were found at operations. In seven cases the stone was single, in four-

teen cases multiple and in eight cases there were seed calculi.

Vesical diverticula were found in three cases. In only one case was it removed.

Urea clearance test was done in 23 cases, urea concentration tests were made in 76 cases. Phenol-Sulphone-phthalein tests were made in 44 cases.

Packing the prostatic cavity was done six times on the table and eight times for recurrent bleeding.

The follow up records of living cases are very poor and are not worth recording. One of my patients is alive and healthy twelve years after operation. He came to me with difficulty in micturition having suffered from it for four months. His urine was clear and phenol phthalam index was 70 per cent for three hours.

## THE SURGERY OF ENLARGED PROSTATE

by S. S. ANAND, F.R.C.S. (Eng.), Surgical Department, King Edward Medical College, Lahore, Punjab.

The attention of the medical profession has been focussed on the problem of obstruction caused by enlarged prostate for more than a hundred years and yet there is no unanimity of opinion regarding the treatment of this condition. At the present moment, however, there are two schools of surgeons: one who favour the open operation, perineal or supra-pubic; and the second who perform the endoscopic resection.

If we study the history of prostatic Surgery we notice that there have been periods of advance followed by periods of stagnation. McGill of Leeds and Belfield of Chicago published in 1887 technique of operations designed to relieve prostatic obstruction and both operators performed a partial supra-pubic prostatectomy. White of Philadelphia in 1893 advised that castration of the patient would lead to the shrinkage of

the enlarged prostate. This idea was taken up by some, to be followed by the operation of vaso-ligation. These procedures turned the attention of the Surgeons from the direct problem of urinary obstruction to the indirect method of dealing with the condition leading to delay in further advance.

In the beginning of the present century attempts were made to solve the problem by removing the prostate more or less completely—both by perineal and the supra-pubic routes. The perineal approach was perfected by Zuckerkandl, Alberian and Young. And to-day Young is the chief exponent of this method. We have had no experience of this method.

The supra-pubic route was first advocated by Fuller in 1895. To Freyer, however, must be given the credit of first describing

the method in detail in 1901 and it is mainly through his efforts that the operation came into universal usage. It became possible to remove the prostate more or less completely and with a good measure of safety.

During the following fifteen years intensive research was made into the problem of renal efficiency with the result that the pre-operative estimation of blood urea became a routine procedure. Some Surgeons prefer the urea-clearance test. We have, however, relied on the former because of its greater simplicity.

In 1920 Thomson Walker described the open operation with control of bleeding under vision. But the increased shock to the patient and the rise of the mortality rate have prevented this procedure from being generally adopted.

In 1929 Harris described his operation of the obliteration of the prostatic cavity with the main idea of arresting haemorrhage and re-trigonisation of the prostatic cavity. This operation can hardly be attempted in the presence of sepsis which is no frequent in the type of cases met with in our part of the country.

The next advance in the technique of the operation was the per-urethral resection of the prostate. In 1935 Gershan Thomson and his colleagues at the Mayo Clinic reported a series of 451 cases without a single mortality in which prostatic obstruction had been treated by the cold punch. According to the opinion of these workers the safety of the operation excels that of any other method of surgical operation available. To Americans must be given the credit of popularising the operation. The average stay in the hospital is said to be from 3-7 days as contrasted with the period of three to four weeks taken by the healing process in the other method. This short stay, however, doesn't include in the statistical records the subsequent deaths due to cardiac failure, sepsis, pneumonia, embolism, etc., which are included in the statistical record of the supra-pubic operations. A further criticism is that the per-urethral re-

section has not eliminated the two complications of which we are all afraid viz., sepsis and haemorrhage. It has in fact introduced a third: extravasation. Young has recently analysed histories of 200 cases of per-urethral resection with imperfect results and has come to the conclusion that the complete enucleation of the prostate is the operation of choice—especially in cases of larger hypertrophy. In view of the diverse opinions and in the absence of any special training in Endoscopic resections, we have never hazarded to undertake per-urethral resection of the prostate in our cases.

We have treated 42 cases of enlarged prostate in our surgical unit at the Mayo Hospital, Lahore, during the last two years. We have come to the conclusion that the Freyer's method of blind enucleation, either in one stage or two stages is the simplest and is the one which can be used by the majority of general Surgeons. In fact it is still by far the commonest operation performed by the Surgeons the world over for this disease. The two-stage prostatectomy is always attended with less risk to the patient.

The criteria which helps us to decide in favour of a two-stage prostatectomy are Severe haematuria, repeated attacks of retention; evidence of poor renal function, evidence of infection of the urinary tract and signs of incipient uraemia, viz., drowsiness, dry tongue, slow pulse accompanied by subnormal temperature, and any chronic respiratory disease. Experience has shown that any of the foregoing conditions demand a "two-stage" rather than a one-stage operation.

In the one-stage cases we depend upon the in-dwelling catheter for preliminary drainage. This is carried on for a period of about ten days. The catheter should not be allowed to hang otherwise sometimes a meatal ulcer is likely to develop and the prepuce should not be allowed to be retracted as this may produce para-phimosis. In those cases where we use an in-dwelling catheter the bladder is irrigated once in 24 hours the fluid used being ordinary saline lotion, this being changed to 1 in 1000 silver



nitrate lotion in infected cases, besides injecting 2 drachms of 2% mercurochrome solution in the bladder at the end of irrigation. In many cases this procedure helps in markedly improving the general condition of the patient and the renal function as shown by the lowering of the blood-urea.

Here it may not be out of place to point out the difference between acute and chronic retention.

*Acute retention* comes on suddenly. The patient looks ill, complains of pain and thirst, and the tongue may be dry. He can be catheterised without any danger of a sudden onset of uraemia due to back pressure on the kidneys.

*Chronic retention* on the other hand is a serious condition: the patient may be a picture of health, may complain of no pain or discomfort with a bladder distended up to the umbilicus and may even have a moist tongue. Such a case, however, shows high blood urea, and may suddenly go into a grave condition of Coma by the sudden emptying of his bladder. These cases, besides, have a great tendency to develop paralytic ileus. The condition can be dealt with by an in-dwelling catheter with an arrangement for slow decompression: a spigot being applied to the end of the catheter and 2-3 ounces of urine being allowed to drain 2 hourly till the bladder is completely empty. Then the catheter is connected by a glass connection and a rubber tubing to a urine bottle hung to the bed frame. It is essential to give plenty of fluids to these patients.

If a catheter cannot be passed, supra-pubic drainage can be instituted by a self-retaining catheter passed through Kidd's Trocar and Canula. This procedure is undertaken under local anaesthesia.

We may now summarise the contra-indications to a one-stage prostatectomy:

1. A large prostate or a prostate which is very congested is likely to cause alarming primary haemorrhage if removed at the first operation. After supra-pubic drainage the congestion is markedly reduced and even

the size of the prostate may become less. Experience has shown that bleeding is much less after a second stage prostatectomy than after a one-stage operation.

2. Acute or chronic retention contra-indicates a single stage operation.

3. Patients with arterio-sclerosis and hypertension do well under a two-stage operation. In several cases hypertension is reduced after the first stage.

4. Large amounts of residual urine.

5. Blood urea above 60 mgms. per 100 c.c. of blood.

6. A pulse rate of 100 per minute or more is a sign of toxæmia and is regarded a contra-indication.

7. Infection of the urinary tract needs a period of supra-pubic drainage.

*When to proceed with the second stage.*—The second stage is only undertaken when the patient has safely been able to combat the ill-effects of back pressure on the kidneys as shown by the lowering of blood urea; and also when the general condition of the patient has improved. The patient is encouraged to walk about. The moral effect of being allowed up is tremendous on these patients and soon they are ready to face the ordeal of the second operation with confidence. It must be mentioned that in several cases the general condition of the patient does not allow the second operation for months and some of them eventually have to pass their days with a permanent supra-pubic fistula.

*Anaesthesia.*—Most of our first-stage operations are performed under local anaesthesia. For the second stage we have invariably used the spinal anaesthesia unless there is some definite contra-indication to its use. The usual premedication in the form of morphia gr. 1/6 with atropine gr. 1/100 is used in these cases.

*Technique.*—Mid-line supra-pubic incision is used to reach the bladder.

Freyer's technique of blind enucleation has been used in all our cases. No attempt is made to remove tags or secure bleeding

points in the prostatic cavity. Primary haemorrhage is controlled by irrigation with hot saline. In some cases packing with gauze had to be undertaken—this certainly adds to the risk of infection and prolongs the convalescent period. The gauze pack is removed after 48 hours. We have no experience of the haemostatic bag. In cases who have had considerable bleeding blood-transfusion is used as a routine.

The bladder is closed round a large supra-pubic drain, with a rubber dam drain in the retro-pubic space. The rubber drainage tube is connected by a glass connection to a tube leading to a bottle hanging on the bed frame.

We have not used ligature of the Vas in any of our cases before the operation.

*Post-operative Measures.*—The siphon drainage is generally sufficient to keep the patient dry.

Daily bladder irrigation is done per urethra. The solution used is warm saline, and in septic cases 1 in 1000 silver nitrate lotion. The patient is encouraged to get up as soon as possible. As a rule the majority of our cases start moving about by the tenth day.

The supra-pubic tube is removed on the 9th or 10th day and a urethral catheter is tied in. The abdominal wound closes in three to four days, when the in-dwelling catheter is removed, and the patient passes his urine with ease and comfort.

*Analysis of Cases.*—In our series 42 cases of prostatic enlargement were admitted in our surgical unit. The youngest patient of this series was 46 years old, and the oldest was 100 years. The average age being 65.2 years.

Of these 42 cases :

8 patients had their prostatectomy in one stage.

13 patients had their prostatectomy in two stages.

11 patients had only suprapubic drainage.

10 patients refused operation.

Of the 21 cases who had their prostatectomy completed 3 died, giving a mortality rate of 14.3%. Of the 11 cases who had only supra-pubic drainage 4 cases died giving a mortality rate of 36.6%.

It will be apparent therefore that most of the deaths occur during the first stage of the operation. Those who have been able to survive the first operation can face the second operation with a much lesser risk.

The high mortality figures are due to the fact that most of our cases arrive in the hospital in the late stage of the disease, many of them are the subjects of chronic retention with uraemia, most of them arrive in a devitalised condition, and a considerable number with infected urinary tracts. It is not easy therefore to reach the standard set by many master surgeons. The only hope lies in the education of public opinion so that the cases come to us in an early stage of the disease.

## CONCLUSION

1. Emphasis has been laid on the indications for two-stage prostatectomy.

2. Mention has been made regarding the difference between acute and chronic retention. The treatment of the latter condition has been stressed.

3. It has been emphasised not to proceed with the second stage of the operation till the drainage of the bladder has produced the maximum benefit.

4. Mention has been made that the greatest risk to the patient is after the first stage of the operation.

5. The Comparatively high mortality in our series is due to the late stage of the disease, at which most of our patients present themselves for treatment.

I am deeply indebted to my chief—Lt.-Col. A. Sargood Fry, C.I.E., I.M.S., for placing the records of cases which were under his care, at my disposal, and for permission to operate on some of them.

## DISCUSSION

*Perineal Prostatectomy*—Dr. V. M. Kaikini: Altogether about forty prostatectomies were performed by me. Out of these about twenty (20) were performed by the perineal route and the rest by the supra pubic. In the operation by the supra pubic route I had four deaths. One death was due to haemorrhage and the other due to uraemia. Lately I did more of the operations by the perineal route. Out of the 20 cases I did by the perineal method I had four deaths. One death was due to haemorrhage, one to acute epididymo-orchitis, and two to uraemia. All these deaths occurred in the first half of the series of the cases. In the beginning my technique was a bit faulty. Instead of reflecting backward the capsule of the prostate along with the posterior wall of the urethra which is to be sutured back in place after the prostate is removed I used to reflect back the Denonvillier's fascia only and remove the prostate along with the capsule and the urethra. This manoeuvre in which the urethra was not stitched to the opening in the bladder usually left a urethral fistula for some days and prolonged the convalescence. Moreover in the case that died of epididymo orchitis I had not done vasectomy which is essential in this method of operation. In none of the early cases was preliminary supra-pubic drainage done but the bladder was drained by a catheter in the urethra. I think all these factors increased the mortality of the operation. In the later operations supra-pubic drainage and vasectomy were done as the first stage operation and then the prostate was removed by the perineal method; and the mortality was nil.

No doubt the operation by the perineal route is definitely more difficult than by the supra-pubic route; but there are so many advantages. In the first place one does the operation under direct vision. Every bleeding point in the urethra and the neck of the bladder is seen and can be tied. The urethra is reconstructed and every raw surface is epithelialised. When properly done the post-operative shock is definitely less than in the supra-pubic method, and the convalescence is more comfortable and much shortened. Taking all these things into consideration the mortality rate is bound to be much lower in the properly done perineal operation than in the supra-pubic type, as is claimed by Young. All the above operations were done according to the same method.

But the chief advantage of perineal method lies in the fact that it is the only method by which a radical operation could be done for a malignant prostate. The method described by Pauchet does not seem to be so radical.

In my experience the atrophied fibrous type and the hypertrophied middle lobe type with the tumour projecting in the trigone of the bladder are not suitable for the perineal type of operation,

although an experienced operator would remove any type of prostate by this method.

The three risks in this method of operation are (1) Incontinence of urine. This can be prevented by being careful in not injuring the external urethral sphincter by opening the urethra as far back as possible. (2) Leaving behind an urethral or faecal fistula. In the majority of cases these fistulae heal up spontaneously. In my two cases of carcinoma prostate these fistulae did not heal up and the patients died eight months and twelve months after the operation respectively. The first patient had been treated in another hospital for malignancy with radium and adhesions had formed between the prostatic capsule and rectum and in trying to separate the rectum the rectal coat got torn and fistulae formed which did not heal up. In the second case faecal fistulae formed during the convalescent period and could not be closed. The patient died of secondaries in the lung.

*H. L. Vaidya*: Out of 120 cases of Senile Enlargement of Prostate admitted under his care in the Sir Takhtsingji Hospital, Bhavanagar, during last five years 1940 to 1945, only 45 submitted to operative treatment; suprapubic operation was done in 43 cases; Transurethral Endoscopic diathermy resection in the other two. 3 out of the 43 suprapubic cases were discharged after simple suprapubic drainage as they were found to be bad risks for prostatectomy; the remaining 40 cases underwent complete Prostatectomy in one stage, and 34 in two stages.

The youngest patient was 45 years and oldest, 75 years. Duration of the complaint—varied from a maximum of 7 years to a minimum of 2 weeks. Residual urine—maximum 20 oz.; Blood urea—maximum 90 m. grms. per 100 c.c. reduced to 35 m. grms. 3 weeks after the first stage operation.

Vesical calculus complicated enlarged prostate in 9 cases. History of Gonorrhoea in 8 cases. Size of Prostate removed—maximum  $3\frac{1}{2}$  oz., minimum  $\frac{1}{4}$  oz., average  $1\frac{1}{2}$  oz.

*Post-operative mortality*—Out of 45 cases, 8 died = 18%; Out of 8 deaths, 5 were due to Uraemia; 3 were due to Pneumonia; none died of haemorrhage; 3 died after first stage; 5 died after the second stage.

*Other complications: Epididymo-orchitis*—16 out of 45. The majority of cases of enlarged prostate sought hospital admission for exacerbations of symptoms during rainy season. He wished to know from the speaker whether he had also observed this and how he would explain it. He also wished to know about the incidence of Epididymo-orchitis as a complication and how to prevent it. Would he advise preliminary vasectomy as a routine procedure? What was the cause of Uraemia developing after the first stage and what treatment he would advise for counteracting threatening uraemia after prostate operations.

**R. N. Cooper:** The beneficial effects of vasectomy on the size of the prostate were doubtful. In one particular case the operation did not in any way influence the size of the prostate. Contrary to the expectations raised by Steinach, the patient actually stated that he had lost what little virility he possessed. He also did not believe that X-Ray irradiation of the prostate did any good to the patient. At the most it controlled haemorrhage in the congestive phase. Epidural anaesthesia with 25 c.c. of a 3% solution of Novocaine supplemented with local infiltration of the abdominal wall with 1% Novocaine gave very satisfactory results. The incision into the bladder should not be carried too low down. Haemorrhage from the bladder wall in this region was particularly troublesome. He did not employ the "finger in the rectum" technique to steady the prostate. He preferred to maintain a hold on the prostate by passing an ordinary rubber catheter per urethra into the bladder and bringing the eye-bearing end right out of the abdominal incision and holding the two ends of the catheter together in the left hand while using the right hand for enucleation.

He referred to persistent pain in the region of the symphysis pubic after an operation for supra-pubic prostatectomy. It was due to an aseptic Osteo-myelitis in the region. It took sometime to clear up.

He pointed out the necessity for repeated passage of dilators into the urethra to prevent stricture formation. He also stressed the importance of forced water intake during the post-operative period.

Administration of about 300 c.c. of matched blood was now a routine procedure with him during the operation.

**Dr. C. S. Worah:** Referred to a series of 50 consecutive cases of Enlarged Prostate at the K. E. M. Hospital, Bombay, in the last 3 years.

The commonest symptom for which treatment was sought was retention of urine (76% of the cases). Frequency, though present in 88% of the cases, rarely made the patient seek treatment (6%). Haematuria was quite rare compared to the figures of other workers. 6% of cases while Young reports 24%. More cases of enlarged prostate were admitted in the rainy season than in any other season.

**M. V. Bhajekar:** Referred to a case under his care who developed symptoms of enlarged prostate in 1941. He was given hormone treatment and was quite well up-to-date.

He used a syphon action apparatus for drainage of the bladder which is much simpler than the one shown by the speaker. It keeps the patient quite dry, without wetting his bandages.

He had observed that some of the prostate cases developed a peculiar mental apathy after their

first operation. It is a common experience that patients operated on for other conditions like—appendicitis or hernia—are always eager to get out of bed and resume normal life. Prostate patients, on the other hand, feel more inclined to stay in bed and are not inclined to make efforts to regain their normal health. In fact they have to be coaxed and sometimes forced to sit up and take to more normal habits; and until they start doing this they do not improve in their general condition and very often their 2nd operation is delayed.

**Dr. V. P. Mehta** gave, further details regarding the 50 cases from the K. E. M. Hospital referred to by Dr. Worah.

1. Weight of the gland varied from 17 gms. to 85 gms.

2. About 17 to 18% of the prostates removed as benign enlargement turned out to be carcinomas on histological examination.

3. Patients started passing urine per urethram after the prostatectomy as early as the sixth day.

4. Post-operative haemorrhage occurred in 11 cases out of 38 and in two cases was fatal.

5. In those cases where packing, suturing or pilchers bag were employed, haemorrhage occurred less frequently and when it did occur it could be controlled easily and was never fatal.

6. Mortality after operation was 13%.

**S. B. Gadgil:** 1. The Vasectomy performed previous to the removal of the prostate, in his opinion, was mainly to prevent Epididymo-orchitis resulting from the spread of infection caused by the operation and not with a view to increase the resisting power of the patient.

(2) When facilities for clinical investigations such as urea-concentration test and any other tests were not available, he had depended on the Sp. Gr. of the urine. When the last two digits of the figure were above 10, he took it that the patient was fit for operation.

3. He had also noticed that a marked enlargement with even retention of urine has often subsided altogether after supra-pubic drainage, and did not know why it was so.

**Dr. M. Authikesavalu:** Transurethral prostatic resection cannot be condemned as an unsatisfactory operative procedure for Enlarged Prostate. I had the opportunity of observing the prostatic bed after transurethral prostatic resection through the cystoscope, while I was working at the Mayo Clinic, U.S.A., where the Urological Surgeons, Doctors Thompson, Emmett and Cook do transurethral prostatic resection for almost all their cases of Enlarged Prostate. Such a prostatic bed does not show any segment of Enlarged Prostate left over. They do the "Hot Punch" were the coagulation of the bleeding point is done simultaneously with the resection. Dr. Crevy at

Minneapolis, U.S.A. does a "Cold Punch", where the prostate is resected transurethraly, and the bleeding points coagulated later.

I have seen these prostatic beds post mortem, years after their transurethral prostatic resection in cases who died of some other ailment and I can assure you that prostatic beds were absolutely clean and devoid of any recurrence.

With proper choice of cases and with proper technique it is certainly possible to remove the Enlarged Prostate by the transurethral method just as in any other operative procedure. The failure of the operation is often attributed to the faulty technique and skill of the operator. Now that the war is over, many of us will be able to get these operating cystoscopes and do more transurethral prostatic resections. As we gain in experience and skill, I am sure we will find it as excellent an operative procedure as any.

The great advantages of transurethral prostatic resection are that post-operative confinement to bed is minimal and the patient is ambulatory in 3 to 4 days; there is no troublesome suprapubic urinary soiling of dressings; age is no bar to this type of operation; properly done, there is minimal loss of blood and the experienced operator does the entire resection in one stage, avoiding a second anaesthesia and surgery.

I have seen Dr. Young's colleagues at Boston, U.S.A., do Perineal Prostatectomy in almost all their cases with excellent results and it is a very popular method in the Eastern part of the United States.

I believe that in skilled hands, one type of operative procedure is just as good as the other, and none of these could be condemned as inadequate or unsuccessful, unless the surgeon gives a fair trial to such operative procedure employing the perfect technique and skill.

R. Mahadevan: I. First of all I want to stress a few points regarding diagnosis.

(a) *Chronic prostatitis mimicking senile enlargement.*—The importance of this lies in the fact that when the enlargement is due to chronic inflammation, the condition may respond to simple measures like periodical prostatic massage and iodine in some form by mouth. Sometimes, cases come with retention of urine and examination shows enlargement of the lateral as well as middle lobes, the latter becoming evident at the suprapubic drainage. A few days or possibly few weeks after drainage, it is found that the patient is able to pass urine per vias naturales and the prostatic enlargement has subsided almost completely. I think such cases are those, where the enlargement has been due to chronic inflammation subsiding with drainage. A true senile enlargement, result of an adenomyoma, is probably unlikely to respond to this treatment. However, the

practical point is this. If in such cases the suprapubic tube is clipped and the patient is then able to pass urine freely per vias naturales, the catheter may be removed, after retaining it clipped for a further two or three days to make sure that the troubles do not restart. The patient need not undergo the operation of resection of the prostate. The case below is a typical one in point:—

A man of 50 came to hospital on 28-8-42 with a history of frequency of micturition, increasing difficulty in passing urine and burning, of 6 months duration but particularly severe for 3 months. There was mild cystitis. Rectal examination showed marked uniform enlargement of both lateral lobes of the prostate. Bladder was found distended two fingers above the level of the symphysis pubis. Soft catheter passed in easily and the bladder was decompressed gradually. On 1-9-42 suprapubic drainage of the bladder was performed when a definite middle lobe enlargement also was evident. The bladder was drained by a big sized Winsbury-White self retaining catheter. On 15-10-42 rectal examination showed that the lateral lobes of the prostate had come down to normal size. Cystoscopic examination showed that there was no median lobe arrangement either. The supra-pubic catheter was therefore removed on 27-10-42. The patient was able to pass urine freely per vias naturales. He was kept under observation for a few more days and discharged cured on 6-11-42.

Some of my colleagues also have had experience of similar cases. The case cited above came with chronic retention. Sometimes, the symptoms are milder. There is no retention of urine and the enlarged lateral lobes become smaller and smaller after periodical prostatic massage and symptoms clear up. Tr. Iodine 5 m. in milk by mouth, thrice daily for a few days helps in the resolution. If there is any associated cystitis it requires treatment by the usual measures.

Sometimes patients come with complaints of sciatica, or symptoms suggestive of seminal vesicular colic. In some of these cases the underlying cause is chronic prostatitis and vesiculitis. Periodical massage of the prostate and the vesicles completely relieve them of their troubles.

(b) *Enlarged subcervical and subtrigonal glands of Albarran.*—Retention cysts, result of blocking of the ducts in the prostatic or urethral glands or in the trigonal area may give rise to symptoms resembling enlarged prostate. The condition may be evident on cystoscopic or urethroscopic examination or may become evident at the time of suprapubic drainage. If associated with chronic prostatitis, treatment as above may succeed. If the prostate also is enlarged, excision of the cyst or cysts and the enlarged prostate may be required.

(c) *Chronic interstitial nephritis may sometimes be mistaken for prostatic enlargement.*—A patient

may come with frequency of micturition and rectal examination may show a slight enlargement of the prostate to which all the troubles may be erroneously attributed. If, in such a case the specific gravity of the urine is very low and there is a trace of albumin in the urine, the possibility of chronic interstitial nephritis being the underlying cause must be excluded before any operative procedure is thought of. This is very important, for, if the prostate is removed in a patient where the troubles are due to chronic interstitial nephritis, he will almost surely die.

(d) Sometimes a hypertrophied inter-ureteric bar may cause retention of urine and in many ways resemble disturbance due to enlarged prostate.—The importance here lies in the fact that the treatment required is resection of the hypertrophied interureteric bar (or an enlarged flapping trigonal mucous membrane) and not removal of the prostate. True, the condition is often associated with enlargement of the prostate but may also occur independent of any enlargement of the prostate. The following case report is interesting from the fact that it occurred in a young girl of 14, where the question of prostatic trouble therefore did not arise. The patient had chronic retention of urine with overflow for 6 months and could never thereafter voluntarily void urine. She had been catheterized outside several times and there was severe cystitis. At the time of admission she was in extreme misery with wetting of clothes and ammoniacal smell, and had high fever. The bladder was found distended well up to the umbilicus. Very careful investigations, including lumbar puncture, neurological examination, etc. etc. could not reveal any cause. Opinion of the physicians also was taken and no obvious cause was detected. Skiagrams revealed nothing abnormal except for a suggestion of hydro-ureters in the intravenous pyelograms. At an exploratory supra-pubic cystomy,

a hypertrophied inter-ureteric bar was detected and this was resected (Figs. 1 and 2). The patient thereafter recovered her control and was able to pass urine freely. It is now just

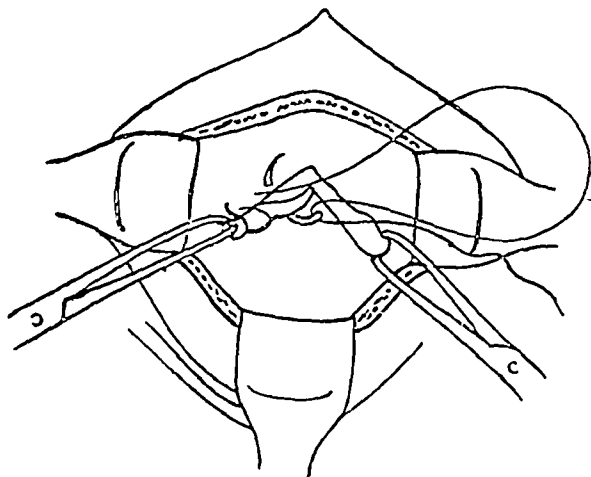


Fig. 2. Removal of trigonal bar or flap which had caused retention of urine. Suture of edges of resulting wound. (After H. H. Young.)

(Both the above figures are from R. P. Rowlands' & P. Turners' Operations of Surgery.)

under four years and she is passing urine freely but her present troubles are due to a persistent mild chronic cystitis with a small amount of residual urine. However, this case typically shows the effect of a hypertrophied interureteric bar.

(e) The importance of noting findings on rectal examination both before and after emptying a distended bladder.—Sometimes patients come in with a markedly distended bladder and rectal examination shows what appears to be an enlargement of the prostate. This however is not there, when re-examination is done after the bladder is emptied. Probably the stretched distended bladder wall gives rise to a feeling suggestive of an enlarged prostate. Sometimes the reverse occurs. There appears to be no enlargement of the prostate but an obviously enlarged prostate is evident when re-examination is done after decompression of the bladder. Such changed findings are by no means common, but they do occur now and again. These facts must be remembered and the findings of rectal examination must be recorded in the case sheet both before and after the bladder has been emptied, for a correct assessment of the state of affairs.

II. The second point I would like to state is that a very great majority of our cases come often with acute retention or chronic retention with overflow and with or without cystitis. I have had no single case where the patient could reasonably have been considered to be fit for a one stage operation.

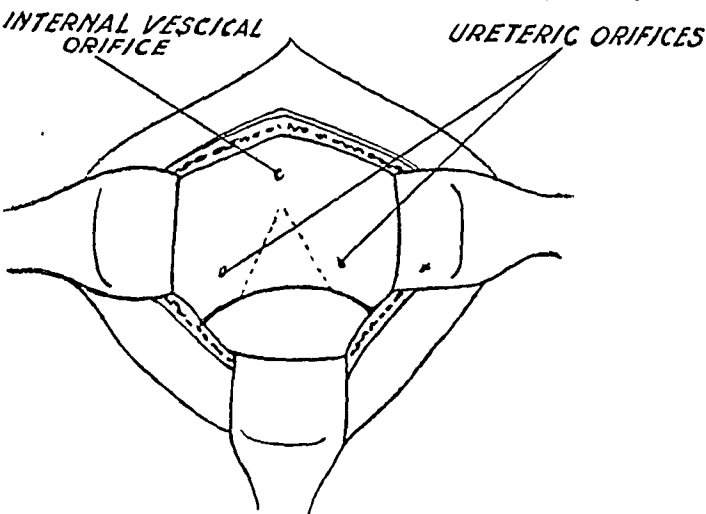


Fig. 1. Removal of trigonal bar obstructing the exit from the bladder. The wedge indicated is excised from the bar or flap. (After H. H. Young.)

Indeed some are so chronically ill that even after months of suprapubic drainage they never seem to reach a stage fit for prostatectomy. I have now on hand two such patients, but I must state both are very elderly patients, one 71 years and one 80 years old.

III. Sometimes the first evidence of prostatic trouble is as an unexpected post-operative complication, where, because of the operation the patient has perforce to be bedridden. Thus, in an elderly patient operated on for a straight forward inguinal hernia, troubles due to retention of urine the result of an enlarged prostate evidenced itself only after the operation. Previous history did not suggest any prostatic trouble. He developed high blood urea and became moderately uraemic. Intravenous drip 4.28% solution of sodium sulphate in 5% glucose and other measures of treatment luckily brought the patient round. After the patient was discharged he was ambulant and was found a year later to be quite comfortable and without any obvious prostatic trouble. In another case admitted for Colles' fracture, the patient, an old man of eighty, became uraemic and actually comatose; with intravenous drip sodium sulphate in glucose he revived in a miraculous fashion. He was known to be alive and comfortable months afterwards. Indeed, in this patient I had earlier refused to operate for hernia because I knew he had an enlarged prostate and anticipated trouble.

IV. *Some details about operative technique.*—Spinal anaesthesia is always of great help, but the anaesthetic effect should be confined to the level of the umbilicus or even lower. If haemorrhage is arrested under vision, post-operative troubles are minimal. Packing and other similar methods of arresting haemorrhage are very poor second bests. Once the haemorrhage is carefully arrested it is enough if the bladder is drained by a big sized Winsbury-White's catheter. Marion's tube is very uncomfortable to the patient because of its large size and extreme rigidity.

V. *Malignant Prostate responding to Stillboesterol treatment.*—A man of 45 is now under my care with a clinically obvious malignant prostate, who has responded well to the administration of "Stillboesterol." He came on 12-7-45 with a history of difficulty in passing urine, starting 5 days earlier and later resulting in complete obstruction. Rectal examination showed markedly enlarged hard nodular lateral lobes with infiltration into the right lateral rectal wall. Bladder was markedly distended. Suprapubic cystostomy revealed markedly enlarged intravesical projection of a hard nodular prostate fixed to surrounding structures. He was put on stillboesterol by mouth and had 281 mgms. in about 3 months. The mass has decreased definitely in size, the nodularity is much less and the patient is able to pass urine through the urethra easily, if the suprapubic tube is clipped. The infiltration in the rectal wall is

however, still quite obvious and if anything is, on the increase. Attempt at aspiration biopsy failed to give any material sufficient for examination. Unfortunately a piece was not taken for biopsy at the time of the suprapubic cystostomy, but the patient is still under my care and I hope to verify the clinically malignant condition by a biopsy.

VI. *Prostatic abscess as a source for pyaemia.*—Recently I had a case of prostatic abscess where the patient developed pyaemia. The abscesses were freely drained, and penicillin therapy instituted, but even with all this the patient went downhill and was taken home very ill. He was a diabetic and this possibly had an important bearing on the unfavourable course. The point is, in cases of pyaemia of obscure origin, one must remember the possibility of the prostate being the underlying focus of infection.

VII. Dr. Moolgavkar was careful to stress on the fact that everybody has his own pet details as to technique and is likely to pronounce his method as the method of choice. In spite of this, I may be permitted to say the following. All the dangers of the operation inclusive of infections and uraemia are directly or indirectly mainly connected with improper haemostasis. Blood clots, and packs in any form to arrest haemorrhage are all fertile sources of infection. Passage of catheters up the urethra is another equally potential source. If haemorrhage is arrested properly, almost all complications can be avoided. It is seriously suggested that the best way of arresting haemorrhage is by the skillful use of diathermy coagulation and avoidance of any ligature material for the purpose. (W. H. Hey, 1945).

In conclusion, may I suggest that the few sudden deaths that occurred a few days after operation in Dr. Moolgavkar's series were very possibly due to "Embolism."

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P. Chatterjee: Retention of urine in patients suffering from an enlarged prostate may be either acute or chronic. Many of these patients come to treatment for the first time during an attack of acute retention. It is difficult often to make out the exact aetiology of the onset of acute retention. Cold and alcoholic excesses that are supposed to play such an important part in some places do not always operate in Bengal. Whatever

they might be, sudden acute congestion of the prostate undoubtedly plays the master role in the pathology. I have found two factors out of others inducing this congestion and initiating an acute retention. They are:—

- (i) Having had to hold urine for a long time either due to want of facility to urinate or out of shyness.
- (ii) Taking of Quinine—to ward off an attack of fever or to cure it, malarial or otherwise. The incidence of acute retention after the ingestion of Quinine has been so frequent that I would not consider it a mere coincidence.

Dr. Moolgavkar is inclined to think that prostatic patients with acute retention do not suffer as miserably as patients with stricture and that spasms do not play an important part in the symptomatology. I do not agree with this idea. These patients do usually suffer from great discomfort and violent spasms—so much so that there is great tenesmus spasm, mucus discharge per rectum and even prolapse.

Talking of residual urine—I have found that confirmed prostate cases may carry on without any residual urine. In others residual urine is fairly large in quantity.

*Cystitis and enlarged prostate.*—Dr. Moolgavkar states that he treats them with Hexamine. If the bacteriological flora is B-coli, hexamine may be considered the best drug, but my experience of the bacteriological flora of cystitis in these cases is that B-Coli is not obtained on culture. Other pyogenic cocci, e.g., Streptococcus and staphylococcus and B-pyocyaneus are fairly commonly met with independently or in association with B-coli. There is therefore place and necessity for the administration of other effective anti-infective

drugs or chemotherapeutic drugs in the treatment of this cystitis. Cystitis is a difficult condition to be completely eradicated. This often stands in the way of successful and peaceful operative treatment in many cases. It is difficult to get a patient for operation who is not already infected. Most cases that are received for treatment have already indiscriminate catheterisation and come with Cystitis. It is safer to establish direct drainage in them.

There are cases where after an acute retention and drainage it takes a long time, say three weeks, at times four weeks and even more before natural urination is established. After this is over, however, some of them carry on a fairly comfortable life so long as a second attack of retention does not occur. I would like to ask the Speaker as to how long he considers it safe to persist with catheter drainage after an attack of acute retention and what circumstances would lead him to interfere.

While doing a prostatectomy by the Suprapubic route, I have found it necessary to pack the prostatic bed very frequently. Suturing the prostatic bed to stop haemorrhage and to reduce the raw surface which ought to be the ideal has not been mentioned by the speaker. I would like to know when he removes the pack? I know of people who would not remove them for 6 days.

The speaker is of opinion that when prostatectomy is not desirable and when the patient refuses the operation, deep X-Ray therapy gives relief for 12 to 18 months. This has not been my experience. Judging from the results of deep therapy in a fairly large number of cases, I am of opinion that the relief of symptoms is very transitory. I would like to know from the lecturer if he has any experience about the role of Diathermy in the treatment of these cases.

## VOLVULUS OF THE STOMACH

*A Case Report by K. KRISHNAMURTHY, M.B.B.S., L. F. Hospital,  
Davanagere, Mysore State.*

Unlike Volvulus of the sigmoid, volvulus of the stomach is a rare condition. Berti in 1866 was the first to report the condition of complete volvulus in a patient at autopsy. Laewen in 1927 reviewed about 40 known cases. Weeder reports that till 1939 there

have been only 70 published cases of complete volvulus.

A consideration of the mechanism of and the etiological factors producing volvulus of the stomach will not be out of place. Buchanan in 1930 and Osman Hill and Mil-



roy Paul in 1939 in two very interesting articles have reviewed the morbid anatomy and etiology of this condition.

The stomach is normally fixed by the Oesophagus to the hiatus in the Diaphragm and is reinforced by the gastro-phrenic ligament. The rest of the stomach lies comparatively free, suspended by folds of peritoneum. The pylorus is however a relatively fixed point on account of the retro-peritoneal position of the Duodenum. Hence a volvulus of the stomach can occur in relation to a line joining the fixed points, viz. cardia and pylorus.

Volvulus of the stomach may be complete or partial. The total form is not strictly a complete volvulus from the anatomical point of view, the gastrophrenic ligament being sufficiently strong to hold the left side of the fundus steady even in extreme torsion. Von Haberer described two varieties of complete Volvulus.

- (1) As in volvulus of the sigmoid, the viscus pivots round a taut mesentery.—Volvulus Mesenterio-axialis.
- (2) The stomach rolling on its own long axis which is a line passing from pyloric to cardiac end.—Volvulus Organo-axialis.

### VOLVULUS MASENTERIO-AXIALIS

In this the rotation is from right to left around a vertical axis at right angles to the Cardio Pyloric line. The pylorus, which is

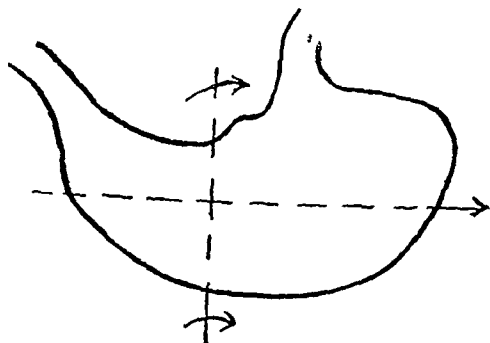


Fig. 1. Volvulus Mesenterio-axialis.  
(Showing the axis of rotation)

more mobile in these cases, passes in front of the fundal end from the right upwards and to the left; a small reciprocal movement being seen at the fundus. The anterior wall, sharply kinked looks backwards while the posterior wall presents under the abdominal wall veiled by the greater omentum. The right half of the colon is carried with the pylorus, upwards and to the left and becomes greatly distended.

### VOLVULUS ORGANO-AXIALIS

In this the stomach rolls on its own long axis, the relatively mobile pylorus is drawn towards the fixed Cardia and a deep sulcus appears on the lesser curve. As the stomach rotates upwards from below, the greater curvature comes to lie below the liver while the lesser curvature rotates to the position of the greater curvature. The anterior sur-

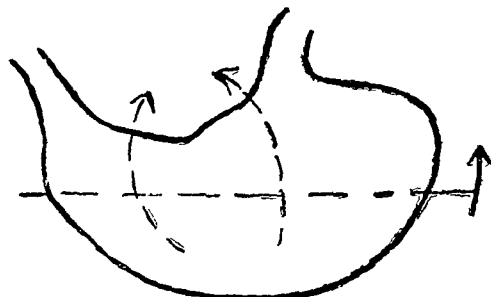


Fig. 2. Volvulus Organo-axialis.

face looks backwards and the posterior surface now presents behind the abdominal wall, veiled by the mesocolon, if the transverse colon is also carried in the upward twist. In some cases the colon remains below, when the stomach is covered by the expanded thin layer of greater omentum as in the present case. There may be displacement of organs like spleen, pancreas, colon, etc.

Considering the extent of twist, there is remarkably little interference with the circulation. While congestion is the rule, gangrene is never observed.

### PARTIAL VOLVULUS

This is of the organo-axialis type (Buchanan). Partial volvulus is always associated

with Diaphragmatic-Hernia, congenital openings in the mesenteries, and with intrinsic gastric lesions like hour-glass stomach, perigastritis, gastric ulcer, etc. It is usually subacute in nature and has little interference with the circulation.

Total volvulus is most often "Idiopathic" coming on suddenly in an apparently healthy individual. In some cases slight elongation of the gastro hepatic omentum and ptosis of the stomach is noticed. Sex incidence is equal, and it occurs in young individuals. Cases have been described in children and is supposed to be due to the horse-shoe shape of the stomach and the pylorus being high—a condition of relative gastropptosis.

Whatever may be the predisposing cause, the immediate exciting cause is invariably overfilling of the stomach, followed by vigorous peristaltic and antiperistaltic waves. In the organo-axialis type it would appear that the actual volvulus is produced by an exaggeration of the normal forward movement of the left border of the stomach in peristalsis, the result of extremely vigorous peristaltic waves. In the mesentrio-axialis type excessive peristaltic waves in a long overloaded loop with a narrow basis of attachment is the mechanism, similar to that of volvulus of the sigmoid. Once volvulus has occurred reduction is prevented by the pressure of the anterior abdominal wall, which holds the distended stomach between the abdominal wall and the diaphragm (Thorek).

### SYMPTOMATOLOGY

In the total variety the onset is acute; severe epigastric pain and vomiting are the earliest symptoms. The vomit consists of stomach contents only. This soon ceases, to be replaced by uncontrollable retching, which is very characteristic. There is great distension of the upper abdomen in the epigastric and umbilical areas. Stomach tube cannot be passed. If operation or death does not cut the process short, it usually ends in perforation of the stomach. This may account for some cases of so called

"Idiopathic" rupture of the stomach found at autopsy.

In the partial variety there is usually an old-standing history of gastric disturbance. Onset is also fairly sudden, with acute pain, repeated vomiting of watery fluid not tinged with bile. The stomach tube can be passed in many cases. In these cases rupture of the stomach does not occur.

### CASE REPORT

*History.*—Patient, Mohammedan male, 26 years, was brought to the hospital on 18-2-1945 at 3 A.M. with the following history. He was in perfect health the previous day. He had been to the pictures and returned home at 11-30 P.M. and had a good meal of rice, curry and eggs. A short time after, he felt his abdomen getting distended and had acute colicky pains in the abdomen. Immediately after the onset of pain, he vomited twice when he brought out part of what he had taken, but subsequently, had only severe retching. Since his symptoms increased, he was brought to the hospital at 3 A.M.

Patient is a young man of average build, in great agony, restless and unable to lie in any position for a short time. He is having attacks of severe retching but no vomiting.

His general condition is fairly satisfactory. Pulse 100 P.M. and B.P. 120 mg. Hg systolic and 80 mg. Hg diastolic. There is a swelling in the epigastrium extending to very near the umbilicus and laterally to both the hypochondria. The lower border of the swelling cannot be well defined. Iliac fossae comparatively flat. The swelling is highly tympanitic suggesting a distended stomach.

*Treatment.*—Soap Water enema was given with poor result. Stomach tube could not be passed, inspite of repeated trials with a view to empty the stomach.

Operated under spinal planocain anaesthesia 1%, 8 c.c. Median Supra umbilical incision was made. On opening the peritoneal cavity, a highly distended and congested stomach covered with a thin layer of

omentum, occupied the entire abdominal wound. Inspection of the rest of the abdomen was impossible. The stomach was punctured with a sterile needle, after protecting the rest of the area, when a lot of gas escaped. The puncture was closed with a double row of purest ring sutures. The distension having been greatly reduced, a careful inspection showed that the greater curvature of the stomach was twisted on its long axis and lying in the region of the porta hepatis and extending to the left. The transverse colon was in its normal position. The stomach was gently untwisted, when it was seen that the area of the stomach lying in contact with the anterior abdominal wall, where the puncture was done, was the cardiac end of the posterior surface of the stomach. The gastro-hepatic omentum was not elongated. The stomach was not fixed. The abdomen was closed in layers without drainage.

48 hours later the patient had slight distension, which subsided, and convalescence was otherwise uneventful.

After complete recovery a barium examination of the stomach showed no abnormality.

### SUMMARY

1. A case of complete volvulus of the organo-axialis type is described.

2. The trial of symptoms, viz., (a) vomiting in the early stages followed by severe retching, (b) rapidly increasing distension in the epigastric and hypochondriac areas, (c) inability to pass a stomach tube, (d) with an acute onset, in a healthy individual is fairly diagnostic of volvulus of the stomach.

3. The mechanism of volvulus of the stomach is discussed.

I am deeply grateful to the Senior Surgeon, Dr. V. V. Monteiro, for kindly permitting me to publish this case. My thanks are also due to Dr. B. N. Balkrishna Rao, Professor of Surgery, for his very valuable guidance and help.

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## HYDATID CYST-THYROID

by D. GOVINDA REDDY, M.D. and M. THANGAVELU, M.B.B.S.,

*Department of Pathology, Medical College, Madras.*

A Hindu male aged 25, a ryot from Cuddapah District was admitted into the wards of the General Hospital, Madras on 27th December 1945 under Surgeon Dr. B. M. Sundaravadanan, with a swelling of 6 months duration over the region of the left lobe of the thyroid gland extending from the middle line of the neck to the sternomastoid posteriorly and from the

angle of the mandible to the sterno-clavicular joint below. The swelling moved freely with deglutition, presented definite margins, tense, cystic and fluctuant. The trachea was displaced to the right but there was no dysphagia or dyspnoea.

A provisional diagnosis of adenoma of the thyroid was made. During the operation

while incising the capsule, the cyst burst and a pale white membrane slipped out,



Fig 1. Thyroid-gland showing hydatid cyst.

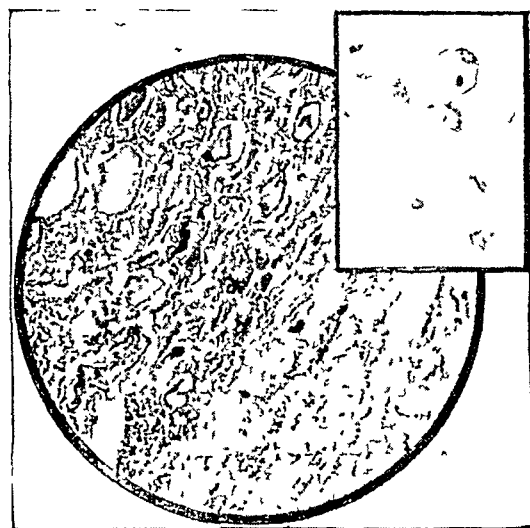


Fig. 2. Photomicrograph showing thyroid structure with ectocyst. In the inset are seen scolices found in the endocyst.

revealing the true nature of the disease as a hydatid cyst (Fig. 1). Blood examination after the operation showed 6% eosinophiles. Casoni's test could not be done for want of hydatid fluid.

*Pathological Report.*—Scrapings from the endocyst showed scolices (Fig. 2 inset).

The ectocyst showed an internal layer of laminated fibrous tissue, an intermediate zone of compressed thyroid acini in various stages of atrophy and peripheral area of normal thyroid gland (Fig.2).

Patient made an uneventful recovery and was discharged cured on 8th January 1946.

### SUMMARY

1. The incidence of echinococcal cysts in the thyroid gland is rare even in countries where the disease is endemic. Landivar as quoted by Joll<sup>1</sup> has collected thirty-one cases up to 1915. In an exhaustive analysis of these cysts Faust<sup>2</sup> has not mentioned the occurrence specifically in the thyroid, but has stated the incidence as 2.8—4.2% in other organs and this probably includes the incidence in the thyroid.

2. Very few of the recorded cases have been correctly diagnosed before operation. One case was diagnosed by Lannelongue<sup>3</sup> and his diagnosis was based upon abrupt variations in the size of the gland associated with repeated attacks of Urticaria.

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# OSTEOLYTIC SARCOMA OF THE LOWER END OF THE RADIUS

by D. GOVINDA REDDY, M.D. and M. THANGAVELU, M.B.B.S.,

Department of Pathology, Medical College, Madras..

A Hindu male aged about 45 was admitted into the wards of the General Hospital, Madras, in February 1945 under Dr. N. S. Narasimham for a swelling of the lower end of the right fore-arm. He gave a history of trauma preceding the swelling. From the clinical findings and X-ray appearances (Fig. 1) a provisional diagnosis of osteo-



Fig 1. Roentgenogram taken in February 1945 showing destruction of the cortex of the lower end of the radius. Appearances are not different from those seen in osteoclastoma.

clastoma of the lower end of the radius was made and a biopsy done. The soft tissues showed chronic inflammatory changes, but unfortunately a report on the bone was not made as the bit was misplaced during decalcification. The tumour was irradiated and the patient discharged improved in March 1945.

In November 1945, he was readmitted for a painful rapidly growing tumour. The growth now extended up to the middle of the forearm and was nodular and fluctuant in areas, with stretched skin and prominent

veins. Radiologically destruction of the lower end of the radius (Fig. 2) and secondary deposits in the lungs (Fig 3)



Fig. 2. - Roentgenogram taken nine months later showing complete destruction of the lower end of the radius. The tumour shadow is also seen.

were noticed. Longitudinal section of the limb which was disarticulated at the elbow joint showed the lower end of the radius replaced by a large sized whitish tumour mass. The cystic degeneration with haemorrhages often seen in osteolytic sarcoma was not present. Microscopic examination showed plump malignant spindle cells, round abortive osteoblasts with numerous mitotic figures and tumour giant cells of the opulis type (Fig. 4 and 5).

## REMARKS

The lower end of the radius is a rare site for osteolytic sarcoma, the common situations being the lower end of the femur, the upper end of the tibia and the upper end of the humerus.

It is commonest between the ages of 10 and 20, but may occur at any age.

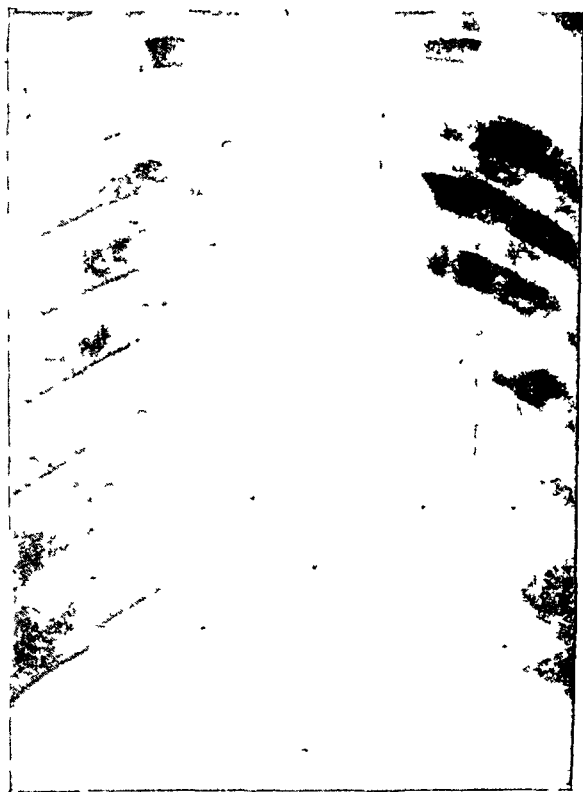


Fig. 3. Skiagram of the chest taken before operation, showing secondaries in the lungs.

In the early stages where there is localised cortical destruction only, osteolytic sarcoma is mistaken for osteoclastoma, since the radiological appearances are almost identical. It may however be remembered that in osteolytic sarcoma there is never bone expansion as in osteoclastoma, but there is destruction of bone including the periosteum.

Since the prognosis and the nature of treatment differ markedly in these two conditions, an early diagnosis is desirable, and that is possible only by a biopsy.

From the recorded cases early amputation or radical resection seems to offer the best chance for a permanent cure. Irradiation must be limited to inoperable cases.



Fig. 4. Low power photomicrograph showing plump spindle cells.

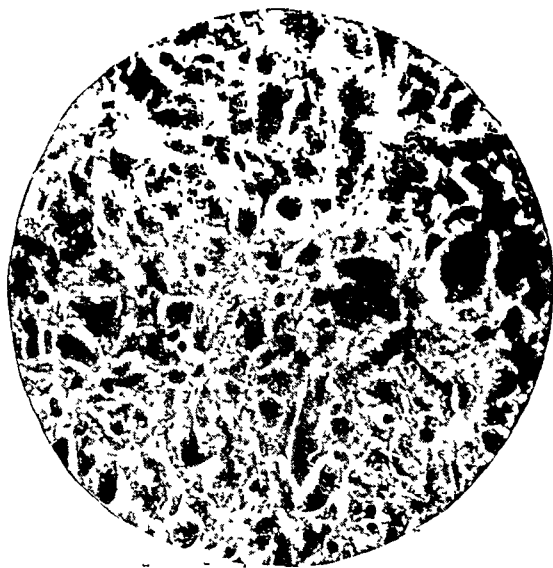


Fig. 5. Medium power photomicrograph showing osteoblasts and osteoclasts with hyperchromatic nuclei and tumour giant cells.

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### The VII Annual Conference

The VII Annual Meeting of the Association of Surgeons of India was held at the Medicine Lecture Hall, Medical College, Mysore, on 27th, 28th and 29th December, 1945 and was, as usual, a great success. Col. V. R. Mirajkar of Lahore presided and Dr. B. N. Balakrishna Rao was the Local Secretary. He was assisted by Dr. M. Athikesavalu, F.R.C.S. (who has now become a member of the Association). They were helped by a Reception Committee under the Chairmanship of Dr. V. V. Monteiro, the Senior Surgeon of the State. All arrangements were made for the comfort of the visiting members and the thanks of the Association are due to the Medical profession of the State for their efforts in making the Session a complete success.

The President and some of the Office-bearers were entertained as State guests.

The Association is particularly grateful to H. H. the Maharajah and his government for the courteous welcome extended to it and for the keen interest which His Highness personally took in the success of the Conference. The Maharajah's Palace and the Gardens at Krishna Raj Sagar were specially illuminated in honour of the visit of the Association.

The formal inauguration of the Conference took place at the Jagan Mohan Palace on 27-12-45 at 9 A.M. In the unavoidable absence, on account of sudden illness, of Dr. T. C. M. Royan, who was to open the Conference, Dr. V. V. Monteiro, the Senior Surgeon of the State, declared the Conference open and read out the inaugural address by Dr. Royan and a message from H. H. The Maharajah of Mysore.

### INAUGURAL ADDRESS AND THE MESSAGE

Ladies and Gentlemen,

It is my great privilege this morning to convey a message from His Highness the Maharaja of Mysore to the delegates and members of the Association of Surgeons of India. The message runs:

### MESSAGE

"I have great pleasure in welcoming to Mysore the Members of the Association of the Surgeons of India to their Seventh Annual Conference. I hope the members will find their brief stay in this City, pleasant and interesting.

Consisting, as it does, of eminent Surgeons from all parts of India, the Conference of the Association will provide valuable opportunities for exchange of ideas on the science and art of Surgery. This is particularly important at the present moment when the rapid progress in the sphere of Surgical procedures made during the war has to be assessed, and I have no doubt this will form a great part of your deliberations at the Conference.

I am glad to see that a full consideration and discussion of these and other matters is greatly helped by your practice of choosing subjects two years in advance and that the monthly journal of the Association serves a useful purpose in making the results of your discussions available to a wider circle.

I wish the Conference success in its proceedings."

To this message I wish to add a hearty welcome to you on behalf of His Highness's Government and the people of Mysore.

I shall not attempt the difficult task of outlining the nature or the scope of your deliberations or of indicating the value of their outcome. But of this I am sure that our own Surgeons in Mysore will feel all the keener and better for the stimulating contact they have had with great minds during this Conference, and our young men of the University Medical College will have throughout their future professional careers, the benefit of the inspiration that your visit to this place has imparted. It is my hope too that this occasion will offer increased opportunities for Surgeons from different parts of this great country to know one another better and to exchange thoughts pertaining to matters of Surgical experience.

This will, I believe, be the first Conference of Surgeons in India after the cessation of the War; and if one considers the momentous discoveries made under the compelling urge of war in the nature of radio electricity, nuclear physics and allied sciences, one cannot resist the feeling that this Conference of distinguished and representative Surgeons of India at Mysore marks the beginning of a new era in the advancement of the art of Surgery in India.

Ladies and Gentlemen, many of you have come here from distant places at very great personal inconvenience and it is my earnest hope that you will feel yourselves at home and enjoy your visit. This beautiful City and its neighbourhood abound in places of historical and cultural interest and I trust that in the midst of your labours you will find time to include some of these in your itinerary.

#### PRESIDENTIAL ADDRESS

by COL. V. R. MIRAJKAR

I am fully conscious of the signal honour you have conferred on me in placing me at the head of your Annual deliberations this year. My only fear is that I may fall short of your expectations and so would ask you to bear with my shortcomings in the same spirit which prompted you in your selection of me.

We have passed through very difficult times these last four years of the devastating war. Even then our enthusiasm for our work and the love and interest in our association has survived. If we look back and consider these difficulties, it appears wonderful and surprising how every year our members have surmounted them and travelled far and near to gather together to show the spirit of professional brotherhood and keenness in their work which is a living thing among them.

So far in our annual Conferences we have dealt with a variety of subjects in the elucidation of which experience and light have been thrown lucidly and I can say that we are definitely much benefitted. At the present Session, among the subjects to be discussed, I am confident you will find important topics which require exchange of

views from members whose experience is valued very highly.

Apart from this line of activity, we have to look farther and extend the usefulness of our Association which will influence the scope of our creative force in the advancement of the knowledge to which we are all devoted.

As you are aware, there has been a proposal which had an unanimous approval, that we should form a body, akin to the College of Surgeons in other countries, which will promote, encourage and be the centre of the highest standard of Surgical work in the country. I can visualize almost in the near future, our Association establishing a Post-Graduate Teaching Hospital somewhere in an area easily and equally accessible to all parts of the country, where research work, specialization and refresher courses for post-graduates will form the chief features.

The necessity for such an institution is keenly felt by everybody and we must take the lead to create such a centre in the very near future. This will be a centre maintained by public benefactions, where research scholars, young enthusiasts wishing to find opportunities to specialize themselves in particular branches of surgery, practitioners who wish to refresh themselves every few years and keep abreast of all advances in our science will find scope to attain their ambitions, and desires, and also where specialists from different parts of the country can meet one another to demonstrate their methods and review their work with one another.

In addition to the above Central body we must make it possible to have in each province a Centre affiliated to the mother unit at the Centre. It is an ambitious scheme that I am placing before you, but if you begin to consider it carefully, seriously and dispassionately, it is not beyond the possibilities of achievement.

The crux of the above problem is finance, but in these days of enlightened thought, people with money will come forward cheerfully when they realise the importance of the work and the benefit that it will confer on humanity. I should not be surprised if our professional brethren, who have done a lifetime's valuable work and the same has been blessed with financial reward, come forward, to initiate this project by their contributions. I would therefore commend this project to your business deliberations and suggest that a definite step be taken at this session to develop it.

I may be permitted to dilate on this subject a little further in order to impress on you the need for such Post-Graduate Training Centres in our country.

As compared to our population, the number of qualified medical men available is proportionately very few, but still fewer are the specialists in



different branches of surgery. The Medical profession is not static though the various medical societies, local bodies and finally through the Government, our Association should sponsor various plans to meet the cost of medical care and to ensure the best care and treatment for the patient. For this purpose, it is high time we recommend to the Government to introduce the Insurance scheme for the care of the sick, it is in vogue in other countries like England and the United States.

Just as we have been educated to buy insurance against all sorts of hazards, so too the public can be educated to purchase health and Hospital Insurance. The privilege to do this is the privilege of every citizen. The bureaucracy even with increasing taxes cannot do it better.

In order to meet this demand, we must have enough number of qualified Doctors and also specialists in various branches of medicine and Surgery. To produce better type of Doctors, we must revise the curriculum of medical education, internship and residentship. Marked expansion of educational facilities will be required. This responsibility rests with the medical profession, medical colleges, and hospitals.

The need for teachers is obvious if this new programme is to be carried out and therefore enough attention should be given to train a sufficient number of teachers to carry out these teaching programmes. A survey should be made of the present facilities, their expansion and possibilities of new facilities.

One word as regards Specialists. Whether or not we practice a Surgical speciality. I regard general surgery as a speciality—the need for broad training in the fundamentals is necessary. I am afraid this is often neglected. I am amazed at the number of students who are about to be graduated, having no conception of writing a good history or carrying out a good physical examination. It is evident that the teaching of these subjects needs a new appraisal. The ease with which a history or physical examination is glossed over and the rapidity with which they reach for laboratory aids is astounding. At times, one wonders whether the present day Clinician has lost his powers of observation and teaching. The over-emphasis on the laboratory side rather than the Clinical side is striking. The fear to make a diagnosis of Renal Stone because the X-ray is negative, the timidity to make a diagnosis of Pott's or Colles' Fracture because there is no X-ray, all causes one to wonder. A case of Tabes with cardinal signs receives no diagnosis until the Wasserman report is at hand. We should teach our young men to make a diagnosis without resorting to all sorts of tests and then to verify the diagnosis with laboratory tests indicated.

History-taking seems to be almost a lost art as is physical diagnosis. Whether we practice general

surgery or one or two surgical specialities, one must look at the patient as a whole, that means, each patient should be viewed as a medical problem, one who may require some type of Surgical treatment.

The practice of medicine tends more and more towards preventive medicine. The Surgeon and the surgical specialist also practice preventive surgery. The importance of the pre-operative preparation of the patient preliminary administration of Iodine to a Goitre patient, the choice of one of the many forms of anaesthesia, the pre-operative transfusion of blood, use of sulphur drugs in the abdominal cavity to prevent peritonitis, use of sulphur drugs and penicillin before extraction of infected teeth, certainly constitute preventive measures.

The value of blood banks has established itself. The life-saving feats of blood banks will soon lead to the establishment of other banks such as the bank for dehydrated nerves, cartilage bank, eye bank, and bank for frozen veins. The frozen veins have proved their worth in the North-African campaign in this War.

Now a few words about Hospitals, their location and their utility. A century ago a hospital was the dreary shelter for the destitute; but today it is the brisk shining centre of all Society's life-giving and life-saving activities. It is the quick development of medical science that suddenly brought the hospital to this new position, and medicine's newer methods require the use of complicated machinery, expensive facilities and varieties of special skills which could be provided best through an institution such as a hospital. Because the hospital today is tied so closely to medicine, it becomes increasingly important that hospital facilities should be made geographically available to all people. Spotty distribution of hospitals means that many of our rural Indians must go without medical or hospital care. Everyday thousands of sick, and injured people are forced to travel many miles away from their homes for hospitalisation or just to see a doctor.

We know there are hospitals all over India, but there is no complete record of our hospital, whenever one wants to know. In many places, anyone can maintain a few beds, offer haphazard care and call it a hospital. We need to know everything about the hospitals all over the country, their location, ownership, the area they serve, physical structure, bed capacity, equipment, capacity for service, qualification of its personnel, financial condition, educational opportunities and research activities.

As early as possible, we must have a hospital map of India with all the details enumerated above. Any hospital with sufficient number of beds and good medical and surgical staff can be taken on our list and noted for post-graduate study. In my opinion, this is the surest way to facilitate the advance of post-graduate study.

Medicine is international; if need be, the shortage of our teaching staff can be supplemented by inviting well-known teachers from foreign countries with the distinct understanding that they should train our post-graduates. Probably, you are aware what the status of the United States was as regards Surgery before the first World War. I may say, without offence to anybody, that they were no better than what we were at that time. But you will all agree that America is to-day second to none in the Surgical world. How did she manage it? One of the important ways by which they achieved this was by going round all the medical centres in Europe and inducing well-known and experienced teachers to go to America by paying them handsomely on a contract basis on the one condition that they trained up their young medical graduates. Can't we also do the same? Once we bring our country on the surgical map of the World, we can develop our Surgery by rapid strides. There will be mutual recognition and interchange of our post-graduates with those of other countries. I would like that day to come soon so that post-graduate students from Europe and America may come to our country for study just as we send our students to theirs.

It is upto us through our Association to advance Indian Surgery in as short a period as possible and thereby raise our status in the eyes of the World. Our nation has awakened and we are all clamouring for self-rule. But there is no self-rule without self-price. So let us strive our best to reach the summit, I mean the Surgical summit.

You are all aware that the nursing of our sick and wounded is not at all enviable. Our patients would like to be nursed by Indian Nurses. It is the common experience of everyone of you how our civil hospitals were depleted of nursing staff during these years of War. No doubt a large number of them went out to do their bit on Active Service; but scores of our civilian sick did not have good nursing in spite of the teeming millions of our women-folk. Somehow, our ladies have not yet realised their duty towards the sick in general. Besides, the nursing profession is not given its due sense of dignity and honour. Just as purdah is fast disappearing, so also whatever stigma that is attached to this profession should be eschewed and a certain proportion of our educated girls should be encouraged to take to this profession and they should be made to understand that nursing is in fact a branch of medicine. This will have multifarious advantages, economical, social and philanthropical as well. We as an association should do our best to educate our girls to take keen interest in this noble profession.

Everywhere these days one hears of post-war expansion, i.e., expansion of existing hospitals, and building of new ones. We want to give better facilities and better treatment to our suffering sick

and good nursing goes a long way to achieve this. So I recommend that in conjunction with our post-graduate training centres, there should be up-to-date training centres for nurses. If need be, we can even import some teachers to train our nurses. It is important that our middle and upper class girls are induced to take to this profession. These trained nurses will, apart from being good mothers to their children, will also be a source of guidance to mothers in their neighbourhood. I understand that the Madras University has opened a B.Sc. Course in Nursing, a very commendable step indeed, and I wish other Universities also to copy this great example.

Another important question which I would like to bring before you, though it is not directly connected with the Post-Graduate training scheme, is the great need for encouraging some Industrials to start as early as possible a decent surgical instruments and Surgical equipment manufacturing company, including electrical equipment like Diathermy, etc., so that proper standard types of materials and articles, as good as those manufactured in other countries may be produced in our country. Still more, what is urgently required is a branch of the above concern manufacturing Endoscopic instruments such as Cystoscopes, Gastrosopes, etc. These types of instruments have become a daily necessity and we have always to depend on foreign countries for the supply of these and at the same time, we have to pay through our nose. What is still worse is that whenever any of those instruments go out of order, we have to send them to the manufacturers thousands of miles away and we have to wait for months and months to get them back repaired. How we could be associated with this type of Concern, I leave it to the Business Committee of the Association. All I want to say at this stage is that we must get ourselves interested and get the Concern started at a very early date.

As we all know our Association has started a Research on the classification of malignant Tumours and a request was sent out to promote this by sending sections of tumours with their notes to enable the Committee to carry out this important work. The response, I am afraid, has not been very satisfactory. I mention this so that our members may keep this in mind and help as much as they can. This branch of work will form a very important part in the growth of our projected Post-Graduate College.

The Library Fund again has not grown to any encouraging proportions and when it is remembered that a Library will form an integral part of our proposed College, I am sure its growth will be stimulated by your further help.

I would also request you to utilize the Journal of our Association more freely than you have done so far. We require informative as well as authoritative knowledge of the science to which

our Journal is devoted and we would like our younger members especially to come forward with their views and experiences. The Journal should be a fitting ornament of our Association.

I appeal, on behalf of the Association, to the younger generation, to consider it their duty to take a very keen interest in their association and see it gather strength, so that it, in every sense an authoritative, advisory and educative body, will be in a position to give the required considered opinion to bodies like the All-India Medical Council to all the Universities in India and other Educational institutions interested in teaching Surgery.

Much more so, our Association is the proper one, to which similar associations in other countries to approach to, whenever they want to know anything about Surgery in India.

Gentlemen, I am so sorry that Dr. Royan, the Hon'ble Minister for Education and Public Health, who was to inaugurate our Session, is suddenly taken ill and Dr. V. V. Monteiro, the Senior Surgeon of the State, is acting in his place. We all request Dr. Monteiro to convey the feelings of sympathies of the House to Dr. Royan and we all pray that he will soon be well and fit to resume responsible duties. Our Association is deeply grateful to Dr. Monteiro for inaugurating the VII Annual Meeting and request that our deep obligations be conveyed to His Highness The Maharaja of Mysore for the instructive message that he has sent to us at this hour and also we are keenly grateful to His Highness for making it possible for us all to meet in this beautiful town of His (Mysore) and giving us all, coming from far and near, the opportunity to meet and enjoy his hospitality. Please assure His Highness that we will remember this great occasion for a long time to come.

If it may please His Highness, our great request of our Association is that he should also take a keen interest in our Association as he does in other spheres!

It will be a boon to our country if His Highness can make it possible to create a Post-graduate Medical Centre in his Capital, where Research Surgery of the highest standard can be performed, so that it becomes a Centre of great learning, where students from all parts of India and the World may come and learn.

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The first Governing Body meeting was held at the Medical College, Mysore at 10-30 A.M. on 27-12-45 under the Presidentship of Col. V. R. Mirajkar. The Secretary read the minutes of the last two Governing Body Meetings and they were passed. 16 new members who were proposed during the year 1945 were admitted. It was decided to correspond with the Executive members of

other Associations in foreign countries in order to ascertain ways and means of closer co-operation with each other and also to exchange copies of publications.

It was proposed to appoint a Sub-Committee to go through and if necessary suggest amendments and additions to the Rules and Regulations of the Association. The Committee, it was resolved, to be convened in Bombay by Drs. S. R. Joglekar, A. V. Baliga and A. E. De'Sa, with Dr. S. R. Joglekar as Convener. The Sub-Committee should send its report to the Secretary before 31st March, 1946. Admission of Hony. members shall also be considered by this Sub-committee.

It was resolved to award to Dr. V. Ramachandra Rao, the prize for his Essay on 'Infections of the Foot' and the prize was to be awarded at the Annual General Body Meeting on 29-12-45. The subject for the next prize Essay, it was decided, should be 'Surgical Aspects of Amoebiasis'.

A committee consisting of Drs. M. G. Kini, B. M. Sundaravadanan and C. P. V. Menon was formed to go further into the matter of a Library and Building for the Association.

The time and place of the next annual meeting was discussed and the invitation from Lucknow was accepted.

Discussion on the three main subjects fixed for this year were held in the afternoons.

Dr. B. N. Balakrishna Rao delivered a lecture on 'Psycho-Surgery' on the 29th of December after he had demonstrated the operation of pre-frontal leucotomy in the cadaver.

Visits to the Tuberculosis and other Hospitals in the city had been arranged. Excursions to the Chamundi Hills, the Guest Palace and other places of interest like the Palace, Lalitha Mahal, etc., were also arranged.

The usual Dinner of the Association was held at Hotel Krishnarajasagar.

### The Annual General Body Meeting

The 7th Annual General Body meeting was held at 4-15 p.m. on 29-12-45 at the Medical College, Mysore, with the President Col. V. R. Mirajkar in the Chair. More than 65 members were present.

A condolence resolution touching the untimely demise of Dr. T. O. Shah, was passed all the members standing.

The Secretary then read the minutes of the last General Body meeting and the annual report for the year ending 31-12-45 and they were unanimously passed.

The Meeting discussed the question of the publication of a Text Book by the Association and after a long discussion, arrived at the conclusion that the idea may be dropped.

The Secretary then announced that the Governing Body had unanimously resolved to award the prize to Dr. V. Ramachandra Rao of Madras for his Essay on 'Infections of the Foot' and the President presented him with a cheque for Rs. 150. The subject for the next prize essay, viz., 'Surgical Aspects of Amoebiasis,' was announced.

The Secretary then informed the meeting of the invitation from Lucknow to hold the next Conference there and it was decided to accept the invitation. Dr. C. P. V. Menon proposed the name of Rao Bahadur Capt. K. S. Nigam as the Local Secretary, Capt. V. L. Suryavanshi seconded and Capt. Nigam was elected as the Local Secretary. The meeting is to be held during Xmas 1946.

During the Conference, a meeting of the Editorial Board was held in the Medical College with Col. Mirajkar in the chair, in the absence of the Chairman, Col. Pandalai.

Drs. T. Bhaskara Menon of Vizag and B. N. Balakrishna Rao of Bangalore were elected to the Editorial Board on the proposal of the Editor.

The subjects for discussion for the 10th Meeting were next decided as under:—

#### 1. Spinal Tumours:

Opener: R. G. Ginde, Bombay.

Seconder: R. N. Cooper, Bombay.

#### 2. Talepes Equinovarus.

Opener: R. Kalamegham, Trichy.

Seconder: M. Bahadur Khan,  
Hyderabad.

#### 3. Surgical Complications of Typhoid.

Opener: V. G. Vaishampayan,  
Sholapur.

Seconder: A. V. Baliga, Bombay.

The President then read the nomination paper submitted by Drs. V. G. Vaishampayan, V. M. Kainini and a few others proposing the name of Dr. S. B. Gadgil of Bombay as the next President. As there were no other nominations he was unanimously elected as the President for the ensuing year.

It was decided to circulate the Agenda of future General Body Meetings to all the members at least a month in advance.

After the concluding remarks of the President, the Secretary expressed, on behalf of the Association, its appreciation of the admirable way in which the retiring President Col. Mirajkar had conducted the affairs of the Association during his term of Office. The meeting terminated with a hearty vote of thanks by the Secretary to H. H. The Maharaja of Mysore. He also thanked the Reception Committee, the Local Secretary and his

willing Staff of Student volunteers, for their efforts in making the Conference a success.

The Governing Body met immediately after the General Body Meeting with the new President Dr. S. B. Gadgil in the chair. A few more members were admitted.

### The Library

The attention of all members is invited to the Circular regarding the Library. A separate account has been opened and donations and subscriptions may be sent to the Secretary. Suggestions regarding books and journals to be acquired are welcome. Donations will be acknowledged in the Journal from time to time.

### List of Donors

(Since publication of the previous list)

Dr. B. M. Sundaravadanan ..	Rs. 500 0 0
Previous total ..	„ 3,507 0 0
Grand total ..	Rs. 4,007 0 0

### Subjects for Discussion

#### 8th Meeting :

##### 1. Carcinoma of the Rectum—

Opener: Dr. C. P. V. Menon, Madras.

Seconder: Dr. E. J. Borges, Tata Memorial Hospital, Bombay.

##### 2. Carcinoma of the Cheek—

Opener: Dr. B. M. Joly, Delhi.

Seconder: Dr. K. M. Rai, Madras.

##### 3. Hare Lip and Cleft Palate—

Opener: Col. V. R. Mirajkar, Lahore.

Seconder: Rao Bahadur Dr. M. G. Kini,  
Madras.

#### 9th Meeting :

##### 1. Bone Tumours—

Opener: Dr. D. R. Meher Homji,  
Bombay.

Seconder: Rao Bahadur Dr. M. G. Kini,  
Madras.

##### 2. Intracranial Tumour—

Opener: Dr. A. V. Baliga, Bombay.

Seconder: Dr. R. N. Cooper, Bombay.

##### 3. Burns—

Opener: Dr. M. R. Munawar Ali,  
Hyderabad.

Seconder: Dr. G. M. Phadke, Bombay.

10th Meeting :

1. *Spinal Tumours*—

Opener : Dr. R. G. Ginde, Bombay.

Seconder : Dr. R. N. Cooper, Bombay.

2. *Talipes Equinovarus*—

Opener : Dr. R. Kalamegham,  
Trichinopoly.

Seconder : Dr. M. Bahadur Khan,  
Hyderabad.

3. *Surgical Complications of Typhoid*—

Opener : Dr. V. G. Vaishampayan,  
Sholapur.

Seconder : Dr. A. V. Baliga, Bombay.

**Prize Essay on**

**“Surgical Aspects of Amoebiasis”**

The Association of Surgeons of India offers an annual prize of the value of Rs. 150 to the best essay based on original work on ‘Surgical Aspects of Amoebiasis.’

The following are the conditions of the award :

1. The competition is open to all qualified medical practitioners registered in India, who have been in practice for not more than 10 years after qualification.

2. The essay should be based on original work and should be written in English.

3. It should be type-written on one side of the paper only and should not contain the name or other indication of the identity of the competitor. Four copies should be submitted.

4. The name, address and qualifications, however, should be written on a separate sheet of paper and enclosed with the essay.

5. The subject for 1946 is ‘Surgical Aspects of Amoebiasis’ and the essay should reach the Secretary before the 1st October, 1947.

6. The copyright for the winning essay will remain with the Association of Surgeons of India and will be published in the Indian Journal of Surgery. Other essays will be returned to the senders if accompanied by stamped addressed envelopes.

7. The Governing Body may at its discretion withhold the prize if the essays submitted do not come up to the standard.

8. All communications regarding the above are to be addressed to the Secretary, Association of Surgeons of India, ‘Binfield,’ Kilpauk, Madras.

C. P. V. MENON,

*Secretary.*



# THE INDIAN JOURNAL OF SURGERY

Vol. VIII

JUNE & SEPTEMBER 1946

Nos. 2 & 3

## TRAUMATIC SURGERY OF THE SKULL

BY

*Dr. R. N. COOPER, M.S., F.R.C.S., Laud Mansion, Bombay.*

No discussion of traumatic surgery of the skull can be undertaken without a consideration of the essential anatomical, physiological and pathological factors concerned. Even a short study of the evolution of the treatment of head injuries reveals this very significant fact that errors in treatment were due to a non-appreciation of the pathology underlying such injuries. Even as early as 1811 John Abernethy protested against "the propriety and necessity of trephining the cranium under various circumstances consequent upon injuries of the head" even though this method of treatment had the sanction of the Academy of Surgery in France and Mr. Percival Pott in England. Thus it was again, that terms like concussion, commotio cerebri, contusion, compression came into usage without an adequate scientific basis. Even as late as 1902 Cushing's experiments on increased intracranial tension where slowing of the pulse and an increase of blood pressure were noted to occur simultaneously, were wrongly considered as an indispensable sign of increased intracranial pressure and the operation of trephining, under the name of subtemporal decompression, was much abused. No originality is claimed for this paper. It is merely a humble effort to present the subject for purposes of a discussion. Such a discussion may help to reduce the total mortality of head injuries from a high figure to somewhere between 17% and 20%.

### ANATOMICAL FACTORS.

The various articulations between the head and the cervical vertebra ensure a certain mobility to the head which serves to protect

it from injuries. As the head moves in the line of the impact its severity is modified. However, it is important to realise that any violent injury to the head which lifts it away from the body may stretch the components of the brachial plexus and cause paresis of muscles of the upper extremity which may complicate the neurological picture produced by an injury to the intracranial contents.

The frontal and the temporal bones are particularly important, the former because of the association of the air sinuses and the latter because of the petrous portion and its contents and the middle meningeal vessels.

The mechanism of injury involved in penetrating and gun shot wounds is omitted from this discussion because of lack of personal experience in these types of injuries.

Fracture of the skull may be produced as the result of (1) a local deformation, (2) general deformation, (3) or both.

- (1) **Local deformation:**—Fractures produced by local deformation are comparable to a rupture resulting in a green bough as it is bent over one's knee. The rupture always occurs on the side of the convexity. The vault of the skull is elastic and as a direct blow is delivered on a localised area of the skull, the particular area is so indented or deformed that the convex external surface becomes concave and the concave internal surface becomes convex. Should a fracture now occur it will be on the inner surface. Thus it is that the inner table of the cranial bones gets fractured more often than the outer. At the periphery of the indent-

\*A Paper read at the VIIIth Annual Conference of the Association of Surgeons of India in December 1945 at Mysore.

ation fracture occurs in the outer table because of the convexity produced.

Massive depressed fractures caused by large objects travelling at great speed are usually fatal.

- (2) Fractures due to general deformation may be brought about as the result of
  - (a) the head being crushed between two external objects.
  - (b) the head being crushed between an external object and the spinal column, or
  - (c) the head striking against a hard substance when a man is knocked down as in a street accident.

The skull is composed of the vault and the base. The bones composing the vault are more elastic than bones forming the base. Within limits, the skull can withstand a general deformation. A compression of the skull in one direction will cause its bulging in the opposite direction which may result in a bursting fracture. Naturally such a crack will occur at the junction of the elastic vault with the non-elastic base and then spread in different directions. The ultimate fracture pattern will be influenced by the nature of the accident and by certain anatomical peculiarities of the skull.

When the head, in consequence of an injury, is pressed against the spine, the thrust travels through the occipital condyles. Apart from a fracture produced by bursting as described above, a circular fracture around the occipital condyles, due to local deformation, may detach the basiocciput producing a ring fracture of the basiocciput. Fracture patterns are also influenced by the fact that the skull is composed of certain relatively thin plates of bone enclosed within thick buttresses.

Fracture patterns in the base of the skull are influenced by the petrous buttresses and the thickened edges of the sphenoidal wings so that the fracture lines often converge to the pituitary fossa. Yet it is surprising that injuries to the cavernous sinus are not common. Arterio venous aneurism between the carotid artery and the cavernous sinus is rare. Only two cases have come under personal observation. The base of the skull is weakened by numerous foramina and fracture lines

frequently open into these foramina. The sphenoidal fissure is frequently affected. The weakest part of the petrous bone is situated externally where it encloses the middle ear. Fractures through this locality are not uncommon. But only an overwhelming violence will cause a fracture through the middle of the petrous bone. Such a fracture is generally fatal. The ease with which the cribriform plate is fractured is explained by the force being transmitted to it through the internal angular process.

In road accidents in particular, the head may be struck more than once in different directions and it would not be possible to reconstruct an accident from a study of the fracture pattern. This point is of peculiar medico-legal importance.

The dura is more closely adherent to the bone in childhood and in old age, than in adult life. Tears in the dura are therefore associated with fractures of the skull at these extremes of age. It is for the same reason that epidural haematomas resulting from middle meningeal haemorrhage are not found at these ages. In the case of a child, a tear in the dura mater associated with a linear fracture of the skull, acts as a safety valve and permits intra-dural haemorrhage to escape outwards and form a so-called safety valve haematoma underneath the galea. The same mechanism permits the cerebro-spinal fluid to escape under the scalp coverings to form a traumatic meningocele.

The dura is firmly adherent to the bone at the foramina where the vessels and the nerves enter or leave the cranial cavity and take with them a covering of dura matter. Hence fractures through the foramina will tear the dura as also injure the vessels or the nerves at the same time.

The dural partitions within the skull—the falx and the tentoria—are so rigid as to act virtually as bony partitions in respect of all acute traumatic lesions. However, the partitions behave differently in the face of slowly expanding intracranial lesions.

There is only a potential space between the dura and the arachnoid mater. Hence a collection of blood under the dura can occur under three conditions. There may be a tear



in the dural sinus, or a rupture of a cortical vein with a tear in the arachnoid mater or very commonly a rupture of the short communicating veins which drain the cortical vessels into the dural sinuses. These veins have fragile walls. At one end they are anchored to the longitudinal sinus into which they open. For a short distance from this end they are firmly adherent to the dura mater. The rest of their course through the subarachnoid space is short and straight. The mechanism of rupture of these veins will be referred to a little later.

Fractures of the skull however acquire their real importance because of associated complications such as injury of the air sinuses, blood vessels, nerves, meningeal coverings and brain itself. In non-penetrating injuries of the head, the brain and the lepto-meninges may be injured either as the result of local deformation from a depressed fracture or as the result of the movements of the brain within the cranial cavity as the head is thrown violently into motion and subsequently brought to rest.

The movements of the brain within the skull operate in different ways to produce several complications.

- (1) When a man is thrown on his head against a resisting surface, the skull and the brain do not travel with the same velocity because of the difference in their densities. In the initial movement the skull travels faster than the brain. There is a distinct lag of the brain in relation to the skull. Thus when the skull strikes a hard surface and has its movement suddenly arrested in consequence, the brain because of its initial lag still continues to travel in the original direction and slaps itself against certain segments of the skull or the surfaces or the edges of the rigid dural septa. Therefore depending on the axis along which the brain moves all combinations of surface injuries may occur.
- (2) At the pole opposite to the site of the impact the conditions are different. As the skull comes to rest, the brain because of its initial lag continues to move in the original direction away

from the skull. A space is thus produced between the skull and the brain. Momentarily a negative pressure is produced in this pocket. The suction so produced may be sufficient to produce a rupture of the surface vessels. Similar pockets of negative pressure may be produced between the dural septum and the brain in the other cerebral hemisphere. These injuries away from the side of the impact constitute a part of the so-called *contre coup* damage.

- (3) The sliding movement imparted to the brain as described already can cause a rupture of the tethering veins which drain the cortical veins into the longitudinal sinus. These veins have fragile walls. At one end they are anchored to the longitudinal sinus into which they open. For a short distance from the end they are firmly adherent to the dura mater. But the rest of their course through the subarachnoid space is short and straight. Hence in sliding movements of the brain in an antero-posterior direction, as in falls on the forehead or the back of the head, they are most liable to rupture. It is easy to see how such haemorrhages are often bilateral. The accumulating blood tends to gravitate to the most dependant part of the subdural space as determined by the position of the head as the patient lies in bed. The accumulation usually occurs in greatest bulk over the surfaces of the temporal lobes.
- (4) The large basal arteries because of their tortuosity and thickness of walls escape injuries due to sliding action of the brain within the cranial cavity. Different is the case with the straight basilar artery and its short symmetrical branches coming out at right angles from the parent artery. A tearing of these small branches produce symmetrical medullary haemorrhages in fatal cases.
- (5) The same gliding movement can account for the avulsion of cranial nerves.
- (6) The brain is not of uniform density. The cerebellum is lighter than the

corebrum and hence it suffers less because of lessened momentum. The density of the cortex and the pons is not the same. Each hemisphere is separate from the other being connected through the corpus callosum and the commissures. The cerebellum is similarly connected with the cerebral hemispheres through narrow pathways. Hence the different parts of the brain can move simultaneously or independently of each other and a kind of gliding action can occur between two adjacent components of different densities with the result that the connecting pathways may easily be bent, stretched or torn. These gliding movements within the brain itself may also cause tearing of blood vessels with resulting punctate haemorrhages. Had there been no cerebro-spinal fluid to act as a water cushion the damage produced by these gliding movements would have been greatly accentuated. Thus in all closed injuries of the head, the brain is subjected to various distorting forces which may produce different types of pathological lesions.

Before embarking on the pathology underlying different types of brain injuries it is advisable to consider briefly a few points in the physiology of circulation of (a) arterial and venous blood, (b) the cerebro-spinal fluid, and (c) perivascular and perineuronal or tissue fluids.

It is to be remembered that the brain is enclosed in a rigid casing. The compressible components are the three fluids referred to above and the brain substance. Normal physiology depends on a proper balance being maintained among the four components. Any departure from this balance constitutes pathology.

Despite the popular belief it must be pointed out, that there is a fairly free collateral circulation among the different arterial branches and that these are not end arteries. The six branches arising from the Circle of Willis are distributed all over the cerebral hemispheres. Some of these supply the basal ganglia, the choroid plexus and to a certain extent the deep white matter. Most of the branches, however, soon reach the surface of the cortex and sub-

cortical white matter. These branches keep on sub-dividing to form the capillary bed. The arterioles and capillaries have a wide anastomosis with branches from other arterioles and even meet and join with the branches of the deep vessels that have come up through the white matter and even the ganglia. Further it has been definitely established that cerebral arterioles have a sympathetic nerve supply. Recently a vaso-dilator mechanism of the cerebral arterioles has been demonstrated.

There is also a chemical control of the vessels. Increase of  $\text{CO}_2$  content of the blood produces a local vaso-dilatation. Histamine, ergotamine tartarate, and amyl nitrite also produce a dilation of the cerebral arterioles.

The amount of blood within the intracranial cavity is dependent on the size of the vascular bed. As all the existing capillaries are not functioning at any given moment the size of the vascular bed will vary. The lumen of the arteries and their branches is smaller than that of the corresponding veins and their corresponding tributaries. Therefore the total arterial bed is smaller than the total venous bed. As the veins are more collapsible than the arteries any slow expanding lesion in the cranium will first affect the venous bed by compressing it. As the venous bed is larger than the arterial bed no demonstrable harm ensues until such time as the compressed venous bed remains equal to the arterial bed. If any further compression of the venous bed ensues, venous congestion will be produced. The rise of venous pressure attendant on compression of the venous bed will interfere with the absorption of the cerebro-spinal fluid. This will lead to an increase in the quantity of the cerebro-spinal fluid as also an increase in its pressure within the cranial cavity. Naturally this must lead to an apparent increase in the volume of the brain. This will be compensated within limits by the cerebro-spinal fluid being driven from the cranial cavity into the spinal dural coverings and being absorbed from venous channels along the spinal nerves. There is however a limit to such absorption and resulting accommodation to increased brain volume. As the skull is a rigid structure any further increase in the volume of the brain will cause further compression of the thin walled veins with resulting further increase in venous pressure. Thus a vicious circle is set up.

As already stated, the total volume of blood within the brain depends upon the extent of the vascular bed. The size of the vascular bed depends on the number of functioning capillaries. As all the existing capillaries do not function in any tissue all the time it follows that the total amount of blood volume must vary. Therefore all the capillaries of the brain start to function and should they also dilate at the same time it is easy to see what a large amount of blood will be trapped in the brain capillaries causing an increase in brain volume with the attendant train of events.

It is interesting to note that in the cellular layers of the cortex, the capillaries are extremely numerous and can be seen to run very close to each individual cell. As established by careful histological studies there are approximately 1000 m.m. of capillary length in 1 cubic m.m. of gray matter and about 200 m.m. in the same amount of white matter. The role of the capillaries in the production of certain pathological pictures has not been fully appreciated.

The circulation of the cerebro-spinal fluid has been called the third circulation by Cushing. There is no central pump, yet the circulation of the cerebro-spinal fluid is dependant on the integrity of the blood circulation in so far as the production and absorption of the cerebro-spinal fluid is concerned. The pressure of the cerebro-spinal fluid is lower than the arterial capillary pressure, but greater than venous pressure in the dural sinus. Cerebro-spinal fluid is manufactured from the choroid plexus within the ventricles. It is either a transudate or an active secretion. Any drop in the arterial pressure will diminish production at the choroid plexus end and any increase in the venous pressure will prevent absorption. Absorption occurs at the venous end mainly through the medium of the Pachionian bodies. A certain amount of absorption occurs in the spinal column through venous channels along the spinal nerves. Should the Pachionian bodies be clogged by the entanglement of red blood corpuscles etc., as does happen in cases of cerebral injuries, absorption will be interfered with and the cerebro-spinal fluid pressure rise and in its turn produce a vicious circle by increasing the brain volume and thus compressing the venous bed. The normal pressure of

the cerebro-spinal fluid as measured by a lumbar puncture in the horizontal position is between 50—150 m.m. of water. In the erect posture the pressure is higher. The pressure of the cerebro-spinal fluid is mainly influenced by the increase in intracranial venous pressure. This is the basis of Queckensdt's test.

**THE TISSUE FLUID:**—All large and small arteries and veins contained within the brain are enclosed in a perivascular space. This space demonstrable in the larger vessels is not discernible in the capillaries. However the arrangement of the supporting glial tissues about the smaller vessels is such as to create a potential space. When this space is distended as in a case of generalised oedema of the brain, it is seen to be continuous with the perivascular space around the larger vessels. Further the perineural and pericellular spaces have been seen to be continuous with the pericapillary spaces. The fluid that is present in these perivascular and perineural spaces is known as tissue fluid. This fluid escaping from the pericellular spaces, passes into the ill defined peri-capillary spaces and thence into the perivascular region. A part of the flow continues towards the surface of the brain and finally empties into the subarachnoid space. Thus it must be remembered that the cerebro-spinal fluid is not a pure product of the Choroid plexus but it also receives a small amount of the tissue fluid. It must not be assumed that all the tissue fluid escapes into the subarachnoid space. The formation and absorption of the tissue fluid depends upon the hydrostatic pressure at the arterial and venous end of the capillaries and upon the osmotic pressure between the blood and the tissue fluid. Normally the arterial capillary pressure is 33 m.m. of Hg. and the venous capillary pressure is 16 m.m. Hg. Hence the flow of tissue fluid is from the arterial capillaries to the extra cellular spaces and from there into venous capillaries and partly into subarachnoid space. The osmotic pressure in the arterial capillaries is 25 m.m. of Hg. and 26 m.m. Hg. in the venous capillaries. Normally the osmotic pressure of the extra cellular fluid is less than the osmotic pressure of the blood. Hence normally the flow of the tissue fluid is from the tissue spaces into the blood stream. However should the capillaries be damaged and their permeability altered permitting the escape of protein molecules into the tissue fluid, the osmotic tension

of the tissue fluid would rise and more fluid would be attracted into the tissue spaces and oedema would result, and the tissues become water-logged. This oedema or water-logging will be accentuated by any rise in the venous pressure which will interfere with the absorption of the tissue fluid. This is the basis of the all important phenomenon of oedema of the brain. The increase which the tissue fluid undergoes during this pathological process is phenomenal. This increase also leads to an increase in the brain volume. This causes therefore a further compression of soft walled veins and the venous pressure rises abnormally high and the vicious circle already referred to is further accentuated.

Cannon has shown that the tissues deprived of oxygen take up fluid and swell. When damming up of venous blood occurs, oxygenation is naturally diminished. Now if it is remembered that the pericellular and perivascular spaces are co-extensive with the arterial and venous channels it is easy to comprehend to what extent fluid can accumulate in these spaces and to what extent oedema can ensue and to what extent intracranial tension would rise with all its deleterious effects. Thus the delicate balance between the cerebro-spinal fluid, the blood, the tissue fluids and the nervous tissue ensures the normal functioning of the brain. Any departure from the normal however produced constitutes the prime basis of pathological processes in the brain. It is well to remember that oedema can be local or generalised.

In all cases of head injury the three demonstrable primary pathological conditions produced are:—(1) Contusion, (2) Laceration, (3) Neuronal damage either anatomical or physiological or both.

All other phenomena such as massive haemorrhages, oedema, herniation are secondary. However Brock states that cerebral oedema has been found in patients killed instantly.

(1) Contusions are very small areas where solution of continuity of brain tissue has occurred. These may be superficial or deep. In each such area there is a haemorrhage of a punctate nature. If the contusion is superficial, the pia mater is not torn and the affected area looks reddish blue in colour. Such areas

may be single or multiple. Gliding movements of the brain within the cranial cavity during a trauma are responsible for these contusions. As the pia is not torn, naturally no blood will be found on lumbar puncture in the cerebro-spinal fluid. The final recovery may be complete or leave behind some residual focal symptoms depending upon the extent of the damage done to the affected area.

(2) Lacerations are gross solutions of continuity in which the pia is torn. Hence a lumbar puncture will show the presence of blood in the cerebro-spinal fluid. The arachnoid may be torn also and a subdural collection of blood or cerebro-spinal fluid may occur. Such lacerations are often found during the course of an operation. Naturally final recovery is more apt to leave behind residual focal symptoms. All cases of contusions and lacerations are not fatal.

In about 7% of the fatal cases symmetrical haemorrhages into the pons and medulla oblongata occur. The basilar artery supplies the pons by branches which leave the main trunk at right angles. With the stretching of the cerebrum from the brain stem which is relatively more fixed, the main vessel is stretched and the symmetrical branches are torn. Such haemorrhages may be the only pathological lesion in fatal cases.

The area of contusions and lacerations undergo healing. The repair may be so complete as to leave behind hardly any trace. On the other hand the repair may be such as to produce definite sequelae, some of which may require surgical interference at a later date for their eradication.

It is not profitable to discuss the exact method of repair which involves the aid of Astrocytes and Oligodendrocytes of ectodermal origin and the microglial cells of mesodermal origin. It is best to enumerate the different end results of healing.

(1) A small contusion heals by a glial scar. The dead tissue in the contused area liquifies. This product of disintegration is removed by the oligodendrocytes which are phagocytic in action. The astrocytes now proliferate in this area producing a typical glial scar. No mesodermal cells take any part here.

(2) Large surface lacerations involve the activity of cells of both ectodermal and mesodermal origin. The mesodermal cells are derived from the neighbouring blood vessels. The scar tissue is therefore partly glial and partly mesodermal in origin. Such scars are adherent to the leptomeninges and the dura mater.

(3) In areas where loss of cerebral tissue is great, nature fills up the space by creation of a cyst lined by fibrous tissue. The fluid is Xanthochromic in nature.

(4) Instead of a scar, degenerative changes of an extensive type may occur producing various kinds of neurological disorders. Thus progressive softening of the brain tissue may result in delayed cerebral haemorrhage first described by Bollinger. Repeated small traumas received by second rate boxers who frequently go down for a count of ten produce a condition known in the boxing fraternity as "punch drunk."

In the syphilitics and the arterio-sclerotics a degenerative encephalopathy may be precipitated or aggravated if already existing. In estimating the after effects of a head injury both these factors must be taken into account.

(5) Associated with a primary injury may be a thrombosis of a vessel which will bring about cortical atrophy. The thinness of the cortex so produced may be compensated by a dilatation of one of the ventricles which is revealed by an encephalographic study.

Sometimes a cavity so produced communicates with the ventricle through a narrow channel.

(6) On rare occasions and particularly in children, a fracture of the vault associated with a tear in the dura and arachnoid mater leads to an escape of the cerebro-spinal fluid in the subgaleal space resulting in the formation of a traumatic meningocele.

(7) Large areas of bone may disappear as the result of malacia or absorption of bone following trauma.

(3) Neuronal damage. Unconsciousness which almost invariably accompanies major injuries to the head cannot be explained on the basis of contusions and lacerations already discussed. These areas only represent focal mischief. To explain unconsciousness it is essential to assume that some neuronal damage is inflicted. The exact nature of such a change in the neurons is under dispute.

Wilfred Trotter formulated a theory which was based on the work of Kocher. Acute distortion of the skull will cause a partial driving out of cerebro-spinal fluid into the spinal sub-arachnoidal space, and a marked compression of not only the veins but also the arteries of the brain. The compression of the cerebral arteries leads to anaemia of the brain resulting in unconsciousness and paralysis of different centres situated at different levels. Thus the paralysis of the occulo-motor centre results in a wide dilatation of the pupils. The paralysis of the vaso motor centre and the cardio-inhibitory centre will produce a low blood pressure and a rapid running pulse. Should the anaemia be of such a profound nature as to continue beyond three minutes death will ensue. However in the majority of cases the anaemia is of a much shorter duration and with the consequent recovery of circulation, a rapid improvement in the neurological condition of the patient takes place.

In this connection it is interesting to refer to some findings in an experimental work undertaken by me and my colleague Dr Ginde. Working on anaesthetised dogs it was found that every blow on the head was promptly followed by a drop in the blood pressure recovery from which was very rapid. A dog's skull is very thick and does not show any evidence of a fracture even after infliction of severe blows. But each blow is accompanied by a marked fall of blood pressure. It seems reasonable to assume that in the human being too, an injury to the head produces such a profound drop of blood pressure as to produce anaemia of the brain and unconsciousness. Our experimental work in this connection is incomplete.

For those cases where recovery of consciousness occurs within a few minutes this theory may be adequate. It does not satisfactorily explain those cases where unconsciousness is much more prolonged and where recovery is of a halting nature.

As Trotter's explanation does not seem to be applicable in all cases it is necessary to formulate another theory which proposes that traumatic unconsciousness is due to a widespread neuronal damage either to the cortical cells or to the sub-cortical pathways. This damage may be physiological, or anatomical or both.

There is no real seat of consciousness in the brain. The proper functioning of all parts of the cortex and the sub-cortical pathways is responsible for the state of consciousness.

Consciousness is the sum total of our awareness to our environments in terms of time and space. Awareness or consciousness is the result of the harmonious perception of various peripheral stimuli—visual, auditory, tactile, labyrinthine, etc., and an adequate and purposeful response to each such stimulus.

The degree of unconsciousness depends on whether there is a total or partial obliteration of the appreciation of such stimuli. Thus in a stage of partial unconsciousness a person may distinguish between light and darkness but may not be able to recognise his surroundings. Even during normal conditions the degree of consciousness may vary. Thus without being personal I may state that my words may be falling on the ears of all but the thoughts of all are not running in the same direction.

It is therefore permissible to assume that in sudden and violent injuries to the head, the sudden movement imparted to the brain causing displacements of hemispheres and the stretching, kinking of the various connections will result in damage to these all important cortical cells where all impulses originate or are finally received or to the axons along which these impulses are conducted. There can be no basic or uniform histo-pathological picture for the condition known clinically as concussion. Presumably both anatomical and physiological injuries occur together. Naturally recovery is relatively rapid where physiological damage preponderates.

The stem forms the pivot round which the movement of the brain occurs. It is comparable to the movement of a fly swapper. Evidently the cortex moves through the largest arc and receives a violent impact and the connecting fibres are stretched, kinked or other-

wise deformed. If the physiological damage is in any sense comparable to a Saturday night palsy, recovery from the effects of trauma would extend over weeks and not hours as so frequently happens.

None of the theories so far given explain the usual picture of a head injury starting with unconsciousness and ending up in a recovery in stages.

I therefore venture to put in a suggestion which occurs to me as a probable explanation of the vague term of concussion.

The initial loss of consciousness may be induced as explained by Trotter. Or else the initial drop in blood pressure after infliction of a head injury, as seen in animal experiments, may produce a momentary ischaemia of the brain which in its turn produces instantaneous unconsciousness. Where recovery is equally rapid one may imagine that the only factor in operation is the sudden ischaemia of the brain.

However in more severe injuries other factors may be coming into play. When we recall that there is a very large capillary bed—1000 m.m. of capillaries in every one cubic m.m. of cortex—we cannot help thinking that the role of the capillaries cannot be ignored.

As the result of trauma to the head there is a generalised trauma to all the structures of the brain. As the result of trauma, histamine or an allied product would be liberated which would produce an enormous vaso dilatation. The hitherto non-functioning capillaries may be opened up. In these dilated capillaries an enormous amount of blood will be trapped. The initial drop in the blood pressure produced by the trauma, associated with the intracranial vaso dilatation materially influences effective intracranial circulation. As the respirations at the time are shallow, sufficiently oxygenated blood will not be available. The lowered  $O_2$  content and the increased  $CO_2$  content will lead to further dilatation of capillaries. The large quantity of blood trapped in these dilated capillaries will lead to an increase of the brain volume. To a certain extent the increased brain volume will find accommodation in the rigid skull case by expulsion of the cerebro-spinal fluid into spinal subarachnoid space. This mechanism is hardly sufficient to meet the situation. The increased volume of

brain therefore causes a compression of the venous bed which accentuates the intracranial pressure by arresting the absorption of the cerebro-spinal fluid and the tissue fluids as already explained. The increased intracranial tension further compresses the venous bed and a vicious circle is set-up resulting in oedema of the brain. The increased  $\text{CO}_2$  tension caused by venous congestion and retarded circulation will according to Cannon induce further oedema. However the increasing  $\text{CO}_2$  tension has a stimulating effect on the vomiting centre and the respiratory centre and the vaso motor centre. If these centres are not irretrievably damaged the blood pressure will rise, aeration of blood will occur and recovery take place. The dilatation induced in the capillaries by histamine-like products persists for sometime, hence the volume of blood trapped in the capillaries will not be displaced immediately on restoration of a more effective intracranial circulation. Complete recovery in a given part of the brain cannot occur till the vaso dilatation dies down in that part. Naturally recovery will be more rapid where capillaries are fewer as in the medulla and slower where the capillaries are more numerous as in the cortex.

In actual clinical practice we do find that recovery starts at the lowest level and then works up to the higher neurological levels. A natural explanation is thus given to this particular method of recovery. Naturally it will take some time for the final normal balance to be restored to the four components—blood, cerebro-spinal fluid, the tissue fluid and the nerve tissue. To my mind the congestive and ischaemic conditions produced by the increased intracranial tension and oedema are responsible for the physiological neuronal damage either to the cortical cells or to the conducting nerve fibres. Normal nutritional needs of the neurons are not satisfied in respect of oxygenation. The nature of the pathological processes just described is reversible hence a recovery from the damage done is possible. That such an increase of pressure does exist is the experience of several of us who have opened up a skull, on the basis of a massive haemorrhage, and have found a congested brain visibly bulging after incision of the dura in the absence of haemorrhage extra or intra dural. Percival Bailey states that brain volume can increase by 50%. Rowbotham in his splen-

did monograph on acute injuries of the head quotes Winklemann and Eckel from their work on histopathology during early stages of brain trauma to the effect that "the capillaries as well as the venules are congested, which suggest that the vascular changes are the result of active participation of the vessel walls in this state rather than the consequence of pure mechanical obstruction due to increased intracranial pressure."

It may be permissible to state that all injuries of the head will result in a total and spontaneous recovery if that part of the brain which is essential to life is not destroyed and if other retarding factors do not come into operation.

These other factors will be enumerated but not described. These are:—

- (1) Shock
  - Primary
  - Secondary
    - Extra dural
    - Acute or Chronic subdural
    - Subarachnoidal
    - subpial (contusions)
    - Intra cerebral
    - Intra ventricular
- (2) Massive haemorrhage
- (3) Collection of C.S.F.
  - Subdural hygroma
- (4) Oedema localised
  - generalised.
- (5) Hydrocephalus
  - External due to blockage of Pachionian bodies
  - Internal (rare due to a clot in Aqueduct of Sylvius.)
- (6) Herniation of the Brain
  - (a) a basal shift due to herniation of one hemisphere under arch of falx.
  - (b) Tentorial pressure cone.
  - (c) Cerebellar pressure cone.
- (7) Infection
  - Meningitis
  - Encephalitis
  - Brain abscess
- (8) Dehydration
  - Early.
  - Late.
- (9) Escape of:—
  - (a) blood through orifices or under the skin.
  - (b) C.S.F. through orifices or under galea.
  - (c) Air—Surgical emphysema—Aerocele.
  - (d) brain substance.
- (10) Injury to cranial nerves.

**CLASSIFICATION OF HEAD INJURIES:—**

A classification based mainly on the anatomical and physiological damage done to the brain is attempted. It is convenient to do so from the diagnostic and therapeutic points of view. Five types of injuries may be described:—

**TYPE (1)**—Injuries where there is only focal mischief to the brain, with or without a fracture of the skull. Unconsciousness may be absent or not noticeable. Such injuries may be brought about by a lathi blow, a tangential bullet wound, a cricket ball (striking the temporal region) or by penetration of skull by a spike with laceration of subjacent cortex.

In such cases the focal mischief is indicated by occurrence of epileptic attacks within the first few hours of the injury. These are probably symptomatic of cortical damage. Other evidences of focal mischief may be a relative weakness of the limbs of one or both sides, defects in visual fields, anosmia, etc. Blows on top of the head may cause paraplegia of both legs as described by Gordon Holmes and is due to thrombosis in the longitudinal sinus.

**TYPE (2)**—Injuries where the underlying lesion is a generalised transient ischaemia of the brain. Unconsciousness in all its varying degrees is present at the time of the injury. With the restoration of effective intracranial circulation recovery is rapid and complete.

**TYPE (3)**—Injuries where a dilatation of the capillaries dominates the underlying pathology. Two subdivisions may be noted.

(a) Injuries where in addition to the reversible organic damage to the capillaries there is additional organic or anatomical damage of varying degrees amounting to contusions of the brain. Here unconsciousness is prolonged. Recovery is the rule but it is sufficiently slow for us

to observe that it occurs in a particular order or sequence. Lumbar puncture in such cases does not show any presence of blood in the cerebro-spinal fluid.

(b) Injuries where in addition to the reversible damage to the capillaries there are not only contusions but lacerations of the brain involving tears in the arachnoid mater. A lumbar tap reveals either a negligible number of red blood corpuscles or copious frank blood in the cerebro-spinal fluid. Recovery is the rule but it is apt to be slow and strong.

**TYPE (4)**—Injuries where in addition to reversible damage indicated under Types 2 or 3 there is an anatomical injury to blood vessels or blood channels (diploic, meningeal, cortical or deep seated) or to meninges. Injury to these structures produce at a certain stage certain symptoms of superimposed phenomena such as the massive haemorrhages, herniations, localised and generalised oedema of the brain. Unconsciousness is the rule. A complete or partial recovery is followed by a deterioration which tends to be progressive. Careful repeated observations indicate the type of complication which is superimposed. Suitable surgical measures alone can lead to recovery.

**TYPE (5)**—Injuries where anatomical damage is so severe as to preclude the possibility of recovery. Haemorrhages into the pons and the medulla are particularly common. Here the patient is unconscious right from the beginning and remains unconscious to the end.

Recovery from head injury may be complete or may leave behind certain residual symptoms. These sequelae will be mentioned at a later stage.



## TRAUMATIC SURGERY OF THE SKULL

The clinical picture produced by these different types of injuries (Type 2, 3, 4 and 5) cannot be of a uniform nature. However clinical manifestations of brain injury in their onset and recovery follow a certain pattern. It is desirable to elaborate these points.

**ONSET**—All severe injuries to the head are attended with immediate unconsciousness. However, the degree of unconsciousness varies. It is important to fully appreciate the fact, that the prevailing degree of unconsciousness at any particular stage after the receipt of trauma is of the utmost diagnostic and prognostic significance. At one end of the scale is coma and at the other end is a mild degree of confusion of thoughts which may go completely unnoticed except by those who are aware of such possibilities.

During the stage of unconsciousness following immediately on a trauma to the head, the eyes are closed. If the eyes are not completely closed one may deduce that either the patient is progressing towards a recovery or sinking into coma.

**COMA**—Coma is a state of complete unconsciousness in which the eyes are half open and the corneal reflexes are either absent or sluggish. The other reflexes such as the swallowing reflex or tendon reflexes are often absent. The patient cannot be roused by either verbal command or by application of a painful stimulus such as pricking of the finger tips or pressure on the mandible. There is retention of urine with overflow.

(2) **Semicoma**—In this state there is some response to a painful stimulus. Forcibly pushing the jaw forwards and holding it there may be resented by the patient who moves his head to escape the torture. Swallowing and corneal reflexes are present. The bladder empties reflexly.

(3) **Confusion**—is a mere clouding of consciousness.

The Medical Research Council of England has graded confusion into severe, moderate and mild.

(a) In severe confusion the patient is inaccessible but can show adequate response to a simple command such as "put out your tongue."

(b) In moderate confusion the patient does not realise his surroundings but can give

relevant answers to simple questions such as "Where do you live?", "What is your name?"

(c) **Mild**:—The patient is capable of coherent conversation but is not yet completely oriented in regard to time, space and person. For instance he may keep on repeating the question he has already asked and which has been answered more than once.

However, there are still a few points to be noted as regards disturbance of consciousness which are not sufficiently appreciated.

Even in the full state of consciousness the degree of consciousness varies. Thus as a mere man you may observe and be conscious of a pretty face. A woman however in your place will also be conscious of the colour of the Sari, the pattern of the jewellery she has worn, the type of shoes she has put on and so forth.

However there may have been an actual loss of consciousness which may be missed. Thus a football player who gets kicked on the head during the concluding part of a game, may appear to rise from the ground and apparently resume the play. To a good observer the player seems to lack initiative. He may be noticed to misjudge situations. After his return to the pavillion he may ask of others what the score was or whether he played to the end of the game or not. Such a person may appear to his friends as not having been unconscious at all. There is no question that the higher functions of judgment and fine discrimination were absent. To that extent the player was unconscious.

Then there is a person who meets with an accident while driving a car. He extricates himself and drives home probably in a seemingly careless and dangerous way. Later he may not be at all aware of all that has happened. To all external appearances he was never unconscious. However, there is no question that his awareness to his surroundings was not complete.

Lastly there is a child who gets hit on the head by a cricket ball. The child may be dazed, but may pick himself up and resume the game. The child may be too young to express himself clearly. The people who saw the accident may definitely vouch that there was no unconsciousness and yet a few hours later a surgeon is

called to see the child in a deep state of coma, with evidence of hemiparesis; I have met with such a case in practice.

These points are of very great medico-legal importance. It is generally argued that in the absence of initial unconsciousness a given injury could not have caused sufficient damage to the brain to warrant the symptoms of headache, giddiness, etc. complained of by a patient claiming compensation.

**RECOVERY:**—In type 2 a man receiving an injury to the head falls on the ground in a state of complete unconsciousness. As described by Trotter this paralysis of the functions may extend momentarily to the forebrain, mid-brain and the hind-brain. The paralytic condition induced by anaemia, in the forebrain, is responsible for unconsciousness, motor and sensory paralysis and paralysis of special centres. Mid-brain anaemia is responsible for paralysis of the oculo motor centre resulting in wide dilatation of pupils. The vital centres governing respiration, blood-pressure and cardio-inhibition are paralysed by anaemic condition of the hind-brain. This gives rise to short shallow respirations, low blood pressure and a fast running pulse. Depending upon the rapidity with which anaemia passes off, complete recovery occurs in a few seconds to a few minutes.

**Type 3:**—If unconsciousness in any sense is delayed beyond a few minutes, factors other than simple anaemia of the brain operate. The probable role of the capillaries in the mechanism involved has already been suggested. As unconsciousness is prolonged with a persistent low blood pressure and shallow respirations, a condition of increased  $\text{CO}_2$  tension of blood is produced, which stimulates the vomiting centre as also the other medullary centres already mentioned. The act of vomiting induces a contraction of the abdominal muscles which forces blood from the Splanchnic areas into general circulation increasing its efficiency and accelerating thereby the process of recovery. The recovery of the vaso motor centre helps to bring up the blood pressure to normal level.

It is important to note that recovery starts at the lowest and ends with the highest neurological levels. Symonds points out that a parallel exists in this respect in recovery from an epileptic fit. First the 'pulse, respirations and blood-pressure return to normal limits. This

indicates a phase of medullary control. The pupils that were widely dilated, become less so indicating a return of function at the mid-brain level. Soon the muscles which were flaccid regain their tone and the face that was placid and expressionless regains its expression indicating that the brain stem is recovering. Recovery of consciousness indicates that the higher neurological levels are returning to normal culminating in full recovery of the highest levels with return of powers of accurate judgment and fine discrimination. In the more severe types of injury of this category recovery of consciousness is a slow process necessitating repeated observations by one who is taught to appreciate the different degrees of consciousness, already described. The slightest sign of alteration in the depth of unconsciousness either one way or the other is a sure indication of recovery or regression. The patient may move a limb. The movement is of a purposive type such as a withdrawal of a limb from a painful stimulus. The patient may now pass from a stage of coma to a stage of semi-coma. He may improve to the stage of confusion associated however with restlessness. The patient may be resistive and even violent.

He may be foul of speech. Gradually behaviour becomes quieter but now a stage of automatism sets in. In this stage the patient will respond naturally to simple questions but is still unaware of his surroundings. He will repeatedly ask a question which has already been answered. He may probably carry on a conversation of which he has no memory afterwards. This stage of automatism, according to Symonds, is comparable to post epileptiform automatism. This stage is of great medico-legal importance. The danger is, that during this phase the patient may make statements which are untrue. Statements taken in such a state should be accepted with a certain amount of circumspection. Often there is a tendency to confabulate. False accusations may be made in connection with the accident.

Succeeding this phase of automatism, patient becomes more rational and recalls events. As he does so, it is found that there is a loss of memory for the injury, as also for events immediately preceding the injury. This loss of memory is known as retrograde amnesia. At first the patient may not be able to recall quite a long period extending over days preceding the accident. Gradually this period

of days shortens into a few hours or a few minutes preceding the accident. Careful notes must be made of the statements of the patient in respect of this retrograde amnesia from day to day. Existence of a retrograde amnesia is very definite proof of so-called concussion of the brain.

There is also a loss of memory for a period following the injury which includes the phase of automatism. This loss of memory is known as post-traumatic amnesia. Recovery is complete only when the patient is fully aware of his surroundings. Post traumatic amnesia ends where full recovery of consciousness begins. It is a truism to say that the longer the period of post-traumatic amnesia, the greater the severity of the injury to the brain. Thus there is a regular sequence of events in the clinical manifestations of a head injury—traumatic stupor, traumatic automatism and traumatic amnesia. The recovery in all head cases is in this fashion. It may be very rapid or very gradual. It is the uniformity of stages and sequence which constitutes the essence of the clinical picture of every head injury.

There are a few other points which are worth noticing. After recovery of consciousness, as the patient remains confused, a certain amount of delirium is noticed in some cases at night. The state of confusion and restlessness is known as cerebral irritation. So long as there is delirium there may be a relapse into stupor from time to time. In the process of recovery there may be halts of varying duration. In our present state of knowledge such irritability is attributed to a varying condition of oedema. A patient who has become sufficiently conscious to answer a few questions may again lapse into stupor and may arouse the suspicion of compression of the brain by haemorrhage. However, in the case of uncomplicated brain injury the set-back does not go very far and there is a distinct tendency towards improvement. In the case of compression the stupor will become more profound.

The pupils, the superficial and deep reflexes show variations depending possibly on varying phases of congestion and anaemia in the different parts of the brain before the normal equilibrium is restored among the four constituents—blood C.S.F. tissue fluid and nerve matter.

During the phase of automatism the patient often complains of a headache. This is not

constant. Hence variable answers may be given to a nurse and a surgeon who may be happening to question the patient at different times.

During the stage of confusion variable plantar responses are obtained—sometimes an extensor and at other times a flexor. The temperature which is at first subnormal may rise a little for a couple of days. It is never higher than 102°. Pulse rate may follow the rise of temperature. In most of the cases there is often a secondary bradycardia which may persist for a week or ten days.

In the more severe varieties of Types 3 the early history is the same as in Type 2, except that the depth of unconsciousness is greater and the duration is often more than an hour. There is generally some shock attending this type of cases. The shock is to be treated in the ordinary way. Should no improvement set in within 2 or 3 hours the case needs careful and repeated watching. Should recovery not follow within 12 hours, one suspects either commencing oedema or subarachnoidal haemorrhage and the question of lumbar puncture is to be considered; a lumbar puncture earlier than 12 hours is not desirable. So many fluctuations occur in the relative balance between blood cerebro-spinal fluid and tissue fluid that any lumbar puncture will be harmful. Experience seems to indicate that stabilization occurs after about 12 hours. Hence it is important to know from this twelve hour period the level of the intracranial pressure as tested by a Spinal manometer. It is believed that the optimum conditions for recovery of damaged cerebral tissue are produced by maintenance of the normal balance between blood cerebro-spinal fluid, tissue fluid and brain matter. With available therapy we can reduce the pressure of the Cerebro-Spinal fluid by repeated lumbar punctures and we can control the volume of the tissue fluids by increasing the osmotic tension of blood by intravenous injection of Hypertonic solutions of glucose and sucrose. The increased osmotic tension of blood promotes the flow of tissue fluids from the perineuronal spaces into the venous channel. This helps to reduce the oedema of the brain.

Should the first lumbar tap show a pressure higher than 150 m.m. of water, sufficient fluid must be withdrawn to reduce the pressure to 50 m.m. which is the lowest limit of the normal.

If the Cerebro-Spinal fluid shows the presence of blood, it indicates a tear in the arachnoid membrane with subarachnoidal haemorrhage. If the cerebro-spinal fluid is heavily stained with blood a four hourly withdrawal is necessary until active bleeding stops as shown by cell counts. It is a practical method to collect the Cerebro-Spinal fluid in a test tube and let it stand. The amount of sediment in each successive collection will indicate whether the haemorrhage is regressing or otherwise. It is an exploded myth that a lumbar tap after 12 hours produces fresh bleeding. A certain amount of stiffness of the neck is noticed in cases where subarachnoid bleeding is heavy. After 18 hours a second lumbar tap should be done even if the case is improving. Should the second reading again show a high intra-cranial pressure repeated tappings must be reinforced by dehydration methods. Magnesium sulphate by mouth or rectum or intravenous injections of glucose rose are now well established procedures.

A third lumbar tap may be indicated after 24 hours. After that a 12 hours tap may be necessary to assure oneself that the intra-cranial pressure is being maintained within normal limits. The maintenance of a normal Cerebro-Spinal fluid pressure is the prime requisite for ensuring the normal relationships among the four constituents of the cranial cavity.

In all cases that do not regain consciousness within a couple of hours the importance of repeated observations has been stressed. Nurses should be trained in this respect. During this period of observation an hourly or two hourly note has to be kept about the level of consciousness, the pulse, temperature, respirations, blood-pressure, the pupils, the appearance of convulsions or any motor paralysis and any alteration of the various reflexes.

These observations will lead one to make certain Surgical decisions.

A case may seem to improve under repeated lumbar punctures and the dehydration measures after the first twelve hours. Then for no reason whatsoever the depth of unconsciousness increases. Reliable localising signs are absent. A right sided exploration (in a right handed person) is indicated. The procedure is the same as for a decompression. Probably the underlying pathology is genera-

lised oedema of the brain. Half hearted measures in the shape of a mere decompression are not satisfactory. Percival Bailey has pointed out that the brain may increase fifty per cent. in volume. On incising the dura the Cerebro-Spinal fluid may spurt to a height of a few inches indicating an external hydrocephalus. The brain underneath may appear pinkish in colour, tense and non-pulsating. Under such circumstances it is best to follow Dott's advice and put in an exploring cannula into the ventricle. If the ventricle is collapsed it indicates an expanding lesion on that side. If the ventricle is dilated it indicates an expanding lesion on the opposite side or in the posterior cranial fossa.

After 12 hours a dilated pupil on one side even in absence of decerebrate rigidity is an indication for a decompression on the side of the dilated pupil.

If after 36 hours the Cerebro-Spinal pressure remains very high without recovery of consciousness a right sided decompression (in a right handed person as ascertained by enquiries to friends or relations) is indicated. It may be stated as an axiom that so long as the cerebro-spinal pressure is high with a good cardiac condition there is hope for the patient.

When diagnosis seems doubtful and unconsciousness is not relieved after suitable measures, increasing use must be made of bilateral inspection holes. An unsuspected subdural haemorrhage or subdural collection of yellowish fluid may reward one's efforts. The holes are most conveniently placed about 1½ to 2 inches above the external auditory meatus.

It is during this period of observation that certain clinical evidence will be forthcoming to indicate a fatal termination.

If the temperature in the early stages rises above 102° and subsequently continues to rise a fatal termination is to be predicted. Extensive lacerations are always accompanied by a high initial temperature.

A secondary rise of temperature in an observed case is the harbinger of death.

A patient may remain unconscious for days but if his pulse and blood pressure remain within normal limits there is hope that the patient may recover. However should the pulse

rate rise and the pressure fall a rapid end is indicated. Normal respirations are always of good prognostication. Stertor is a sign of an early end. A sustained high intracranial pressure in the presence of stupor is an indication for persevering with efforts to save patient's life. It indicates in the absence of subarachnoidal haemorrhage, either a generalised oedema or external hydrocephalus. A low or subnormal intracranial pressure in a comatose patient indicates that the medullary centres are failing.

The presence of red blood corpuscles in the cerebro-spinal fluid indicates subarachnoidal bleeding. The larger the number of red blood corpuscles in the fluid the severer is the injury. However, it is not possible to prognosticate purely from this angle. Russel has observed that red blood corpuscles tend to disappear rapidly from the first day after the accident and that at the end of four or five days the cerebro-spinal fluid becomes clear or yellowish brown in colour. Fresh appearance of red blood corpuscles indicates a renewal of haemorrhage.

Signs of tentorial cone formation appearing within twelve hours indicates extensive generalised oedema with extensive lacerations which are always fatal.

Contusions of the orbital surfaces of the frontal lobes give rise to rapid respirations, elevated temperature and bronchial hypersecretion leading to a mistaken diagnosis of pneumonia.

**TYPE 4:**—In this group there is initial unconsciousness after which there is either a rapid or gradual recovery. The patient seems to remain well for varying periods of minutes, hours or days. This is known as the lucid interval. After a varying length of lucid period certain clinical manifestations appear which indicate the supervention of:—

- (1) Extra dural haemorrhage.
- (2) Subdural haemorrhage or haematoma.
- (3) Subdural hydroma.
- (4) Herniations of the brain
- (5) Hydrocephalus.

An injury of this type may come under the notice of the surgeon when the patient is first knocked unconscious, or when he is conscious

during the lucid interval or when he lapses a second time into unconsciousness.

**Extra dural haemorrhage:**—If the patient happens to be under observation right from the beginning, the first symptom during the lucid interval, to arouse suspicion of an impending complication such as extra dural haemorrhage, is increasing headache. Giddiness and mental confusion follow, leading up to stupor. The stupor may be mistaken for natural sleep should it happen to set in when the patient is naturally expected to sleep. In right handed persons a left sided lesion may proclaim itself by aphasic difficulty.

Extra dural haemorrhage may arise from one of the four following sources:—

- (1) Middle meningeal vessels
- (2) Diploic vessels
- (3) Longitudinal sinus.
- (4) Petrosal, Sphenoidal or cavernous sinus at the base.

Injuries occurring at work or play in the shape of direct trauma over the temporal region are more likely to produce extra dural haemorrhage than an automobile accident. Extra dural haemorrhages are uncommon in childhood and in old age. At these periods of life the dura is firmly adherent to the bone and is likely to tear along with a fissured fracture. The tear in the dura mater acts as a safety valve.

In certain cases of extra dural haemorrhage the injury appears to be of a trivial nature. The extra dural collection takes place usually over the temporal lobes, sometimes over the occipital lobe and rarely over the cerebellum. If the collection occurs over the temporal and parietal lobes convulsive twitchings of limbs occur followed by paralysis. In a fully developed case the pulse is below sixty and the blood pressure is high. A fixed dilated pupil on the side of the haemorrhage may or may not be present. It is usually a late sign. When pyramidal signs, as shown by paresis, are confined to one side of the body, the side on which haemorrhage has occurred is easily determined. If haemorrhage is allowed to progress bilateral motor signs rapidly appear and diagnosis becomes difficult. On the side involved first, spasticity gives rise to flaccidity. Spasticity is due to venous congestion produced by the increasing pressure of the extra dural collection. When haemorrhage continues, the

increasing pressure induces an ischaemia of the cortex which gives rise to flaccidity. But the side on which paralysis appears later is still spastic, when flaccidity appears on the original side. Naturally the side of the brain to operate will be the one opposite that of the flaccid paralysis.

An X-Ray film of the skull showing a crack running through the track of the meningeal vessel will determine the side on which one should operate. A lumbar tap will reveal an increased intra cranial pressure. No red blood corpuscles are present in the cerebro-spinal fluid unless there is an associated tear of the arachnoid mater.

### SUBDURAL HAEMORRHAGE:

Subdural haemorrhage is either generalised and acute or localised and chronic. When localised and chronic it is often spoken of as subdural haematoma.

Acute generalised haemorrhage is generally associated with severe cranio cerebral trauma with tearing of the arachnoid. As the arachnoid is torn some cerebro spinal fluid escapes into the subdural space mingling with the blood and probably preventing its clotting. The acute bleeding comes from the cortical veins. Hence the clinical picture is that of severe types of cerebral injury in which the subdural collection of blood plays but a small part so far as signs and symptoms are concerned. However, in some few cases the collection under the dura may be extensive enough to cause compression symptoms. The latent period may be a few minutes or hours depending upon the rapidity with which blood collects. Sometimes in the earlier stages of initial recovery there is marked irritability to which Trotter has drawn attention. In this stage the patient is violent and is a veritable fighting automaton. Should his breath smell of alcohol a wrong diagnosis of alcoholic intoxication is arrived at and the patient is wrongly taken to a police lock-up. This stage is followed by insidious paralysis and stupor. Again this is looked upon as the soporific effect of alcohol and the patient is found dead the next day in the police cell.

No operative procedure is necessary unless there is an associated depressed fracture or unless there is evidence of compression with manifestation of motor paresis. In fact some acute subdural haemorrhages are discovered while exploring for an epidural haemorrhage.

After opening the dura the blood is best sucked up. If the bleeding point is seen it may be dealt with. It is not wise to search for bleeding points. A cigarette drain is necessary.

### Local or Chronic Subdural haematoma:

The relationship of trauma and particularly insignificant trauma, to subdural haematoma was pointed by Wilfred Trotter in 1914. The patient may be more than just dazed at the time of the injury. The trauma is generally a fall on the frontal or occipital regions. The axis of the trauma is in the anteroposterior direction. It is the gliding action of the brain in an antero-posterior direction which is most likely to rupture the tethering veins which connect the cortical veins with the longitudinal sinus. The most common age is between 40 and 70 years. The most common location of the haematoma is the lateral aspect of the fronto parietal regions rarely over the occipital lobe or the cerebellum. Dandy and Pecl have each recorded a subdural haematoma involving the pituitary region.

Munro has made an extensive study of these haematomas and has divided them into solid, mixed (solid and fluid) and purely fluid. Munro states that the age of a haematoma can be judged either from a microscopic study of the dura and the limiting membrane of the clot or the protein content of the fluid. This age can be determined up to two to four months. The average latent period between the injury and the first appearance of the symptoms is three weeks. However, the onset of symptoms may be delayed by several months. The symptoms are those of an expanding lesion and are therefore progressive. A persistent though intermittent headache after the initial recovery, should always keep one on one's guard. Poor memory, mental confusion, the making of repeated mistakes in ordinary routine work, irritability of temper and change of personality should be regarded as some of the non-localising manifestations of this trouble. Convulsions, paresis or paralysis depending upon direct compression or due to massive displacement of brain causing the opposite cerebral peduncle to be compressed by the unyielding incisura tentori so that pyramidal signs and paralysis may be found on the same side as the haematoma. Variability of signs and symptoms from day to day or even from hour to hour may be a noteworthy feature. Encephalogram may be of value.

However, the best plan is to explore by making burr holes in the temporal region on both the sides if necessary. The dura will look bluish and bulging and on incision will yield a dark red coloured or a light coloured fluid.

**SUB-DURAL HYDROMA:**—A subdural hydroma is a collection of a clear colourless or yellowish fluid under the dura. It is unassociated with a subdural haematoma. Probably at the time of the injury the arachnoid is torn in a valvular manner allowing the Cerebro-Spinal fluid to escape into the subdural space but preventing its return. Such an escape into the subdural space would be promoted by any act which leads to increased intra-cranial tension such as coughing, vomiting or sneezing. The symptoms produced would be similar to those of a subdural haematoma. Diagnosis will be confirmed by an exploratory trephine opening, usually over the parietal area. A careful incision over the bulging dura will cause a gush of clear fluid. The dura is cut in a stellate fashion over the site of the hydroma. Nothing further need be done.

#### HYDROCEPHALUS:

An internal or non-communicating hydrocephalus is rare. An external or communicating hydrocephalus implies that the Cerebro-Spinal fluid can escape from the foramina of Majendie and Luschka on to the surface of the brain, but cannot be absorbed at the natural rate by the Pacchionian bodies which are blocked by disintegrating red blood corpuscles.

An obstruction to the free flow of the Cerebro-Spinal fluid can also occur as the result of an accumulation of a clot under the arachnoid mater on one side. One often sees such a localised external hydrocephalus while cutting into arachnoid mater and finding a stream of yellowish or lightly blood stained fluid spurting out under great pressure. The condition necessitating such an exploration would be a delayed hemiplegia.

**HERNIATION OF THE BRAIN:**—The evil effects of straining on the brain volume are well-known to surgeons who some times see a brain visibly enlarging during a cranial operation. Thus during craniotomy struggling on the part of the patient as the result of unsatisfactory anaesthesia, leads to a prompt bulging of the exposed brain through the bone opening engorgement of its vessels and even spontane-

ous rupture of some large cortical vein. If the cranial cavity is intact it is easy enough to realise that as the result of increased brain volume or increased tension in a supra tentorial compartment a part of the brain may be squeezed out of one compartment into another. Such a process is known as herniation. The brain may swell as much as fifty per cent. of its volume as the result of trauma. Oedema which accompanies every severe brain injury, may be either localised, when it produces focal symptoms, or may be generalised when it causes different kinds of herniations.

Apart from oedema, intra cerebral or subdural haemorrhage may also cause herniation by raising the intra-cranial pressure in one dural compartment sufficiently to force the contents out.

Herniations occurring within twelve hours of the receipt of a trauma are always fatal and are due to a very rapidly spreading oedema of the brain. Herniations which take longer to develop are amenable to surgical procedures, as they are usually the result of accumulation of blood in a supratentorial compartment. Three distinct types of herniations may be described.

(a) The tentorial pressure cone. Jefferson coined this name and described its mechanism. A rise in the supra-tentorial part of the cerebrum will force the inner surface of the temporal lobe (uncus) through the opening of the tentorium and produce a herniation. The herniated portion displaces and compresses the mid brain. The efferent and afferent impulses from and to the cortex are cut off and the neural mechanism below the ring of compression is released from the control of the higher centres. The Red Nucleus is situated at this level and has an inhibiting influence on the contraction of muscles maintaining an upright posture. If the nucleus is put out of action, the muscles responsible for maintaining erect posture are released from its inhibiting influence. Such a release phenomenon gives rise to the condition of decerebrate rigidity. All the muscles of the body and limbs become rigid in the extended position. Thus the hips and the knees are fully extended and the ankles plantar flexed. Any attempt to move the joints passively is defeated by the sustained spasm. With the establishment of decerebrate rigidity the Red nucleus ceases to function. Deiter's nucleus situated at a level

continues to function. When Deltor's nucleus is also thrown out of gear, the extensor muscles become relaxed and the flexors go into a spasm so that the body and limbs show evidence of acute flexion. Further, at the tentorial level is situated the third cranial nerve, which may be stretched or compressed by the process of herniation. Such an injury to the nerve produces a dilated and later a fixed and dilated pupil which is of considerable value both as a diagnostic and a lateralising sign. If unrelieved, the tentorial compression leads to deepening coma and death. If treated efficiently it constitutes the dramatic in surgery by the prompt restoration of consciousness. In some cases tentorial herniation may be bilateral. To a less extent the cerebral peduncle of the opposite side is pressed against the sharp margin of the tentorial aperture and symptoms of paresis will manifest themselves also on the opposite side.

#### THE CEREBELLAR PRESSURE CONE OF CUSHING.

If the rise of pressure in a supra tentorial compartment is very slow as in the case of a subdural haematoma or an intra cranial tumour, the dural partitions of the tentorium yield quite considerably and the increased pressure is distributed more equitably with the result that the infra tentorial compartment receives its share as well. Local herniation under the tentorial aperture does not occur. However, the bony ring at the foramen magnum will not yield to the increased pressure in the infra tentorial compartment and the evil effects of the increased pressure will be felt at this level. Thus the rising pressure in the infra tentorial fossa may force the tonsils of the cerebellum through the foramen magnum into the spinal column, producing a compression of the medulla. The striking features of such a herniation are rigidity of the necks, spasticity of the extremities and a marked increase in intra cranial tension resulting in a secondary hydrocephalus produced by a virtual closure of the apertures of the fourth ventricle. A choked disc may be noticeable. Respiratory embarrassment is particularly common. Spinal puncture in such a case is truly dangerous.

#### BASAL SHIFT OR HERNIATION UNDER THE FALX.

This occurs in cases of rapidly increasing intra-cranial pressure in a supra-tentorial compartment, when a part of the brain in that

situation is forcibly dislocated under the arch of the falx. The main clinical feature is impairment of consciousness.

X-Ray investigations play a minor role in the diagnosis of closed head injuries. Hence skiagraphic studies should not be undertaken until the patient is well out of shock. From the practical point of view the importance of a skiagram lies in the positive evidence it affords in suspected cases of epidural haemorrhage. A fracture line passing across the course of the middle meningeal artery or its branches would give a definite indication for surgical interference. A skiagram has a distinct medico-legal importance. A skiagram depicting a fracture is looked upon as the most convincing argument in a court of law to prove that a serious injury to the skull and its contents has occurred in a given case. A fracture line may be noticeable for three or four months in a child and probably for a year in an adult after the date of the accident. A linear fracture of the base is often missed because of overlying shadows. Clinical evidence of a fracture of the base is more important than the radiological evidence. In interpreting a skiagram linear fractures may be confused with meningeal grooves, diploic channels and suture lines. However, a fracture line can run in any direction. It has clean cut edges. Any change in the direction of the fracture line is abrupt. It may cross arterial or suture markings. The fracture line is wider at its origin than its termination. In a comminuted fracture there is a central splintered island or bone from which linear fracture lines radiate. This type of fracture indicates severe cerebral damage. Depressed fragments are best detected by a stereoscopic radiography. An inward displacement of 0.5 c.m. or more is sufficient to press upon the brain. Such a depression, when detected, constitutes an argument for either an elevation or a removal of the fractured fragment. The presence of an air bubble in the cranial cavity is easily demonstrated in a skiagram and is of some prognostic significance. The locked up air is a potential source of infection. Browder in a personal communication to Brock states that in 10 out of 15,000 cases of head injury the presence of air was demonstrated in the ventricles.

Ventriculography and encephalography are beginning to be recognised as of some value in



acute traumatic lesions when unconsciousness either persists or regresses after 24 or 36 hours. Ventriculography is safer than encephalography because less air is used. Further the air can be reaspirated at the end of the investigation. There is a less likelihood of a cerebellar or tentorial cone being precipitated. The procedure also enables one to maintain intra-cranial pressure within normal limits.

Ventriculography, encephalography and electro-encephalography have a great value in revealing very important information in respect of some of the sequelae of head injuries such as epileptic seizures.

### THE TREATMENT OF CLOSED INJURIES.

Head injuries can stand transport better than abdominal casualties. Transport by aeroplanes above an altitude of 4,000 feet is not advisable. To maintain a free air way and prevent a falling back of the tongue, a lateral posture is to be adopted during transport. This position also allows the saliva to trickle outwards. A quiet darkened room in a well equipped hospital is highly desirable.

The treatment of co-existing shock has already been emphasised. Training the nursing staff to recognise the different levels of unconsciousness is very important. Unconsciousness is the most important sign indicating the extent of generalised damage to the brain. An increase or a diminution of the depth of unconsciousness is the most practical demonstration of recovery or deterioration.

**Position of the head:**—The head may be kept low if there is any associated condition of shock. After the condition of shock has passed off, the head may be kept elevated to prevent venous congestion. Once the cerebro-spinal fluid pressure is found to remain normal, the head should be kept level with the body or even lower. Should headache return, the head of the patient must be kept low again. In truly traumatic headaches the head low position gives prompt relief. A malingerer will of course not be relieved by such a procedure. He will find the position and the enforced rest too irksome for him to continue to plead a post-traumatic, headache!

**Restlessness:**—Reassuring a patient that everything is being done for his good goes a long way to soothe him. Protection of the patient against accidental falls from a bed may

be ensured by converting an ordinary bed into a cradle by providing side-supports. Forcible restraint increases struggling with attendant rise of intra-cranial pressure. A straight-jacket has no place in the treatment of head injuries. Soluble luminal grs. III given intravenously followed by chloral hydrate grs. X and sodium bromide grs. XV are adequate measures for controlling restlessness. Paraldehyde four drachms in six ounces of oil per rectum is also useful. Morphia is best avoided. Ice caps are of doubtful value. Munro suggests that the only conceivable use of an ice-bag is in an uncooperative patient. Such a patient may be rendered somewhat quieter because of a possible subconscious desire to successfully balance it and thus obviate the imagined disorder that might result from its dislodgement.

**Feeding:**—If oral feeding be not possible a small-sized duodenal tube may be passed through the nose to reach the stomach. Temple Fay of Temple University, Philadelphia, is a great advocate for restricting the fluid intake for the first two or three days. The daily output of Cerebro-Spinal fluid can be reduced by restricting the fluid intake. Diminishing the amount of Cerebro-Spinal fluid will certainly help to keep down the intra-cranial pressure. It is therefore desirable to withhold fluids but not to such an extent as to produce the toxic effects of dehydration. These toxic effects are very liable to be produced particularly in children. The toxic effects of dehydration may be noticed either in the first 2 or 3 days or later between the tenth and the fourteenth days. It will be precipitated and accentuated by vomiting or excessive sweating. The suspicious signs are a dry mouth, a furred tongue, a non-elastic skin, a sunken condition of the eyes, a rising temperature, delirium, increasing stupor and a subnormal Cerebro-Spinal fluid pressure. The quantity of urine is diminished. Its specific gravity is high. There is a trace of albumin in the urine. Casts may be present. Prompt relief offered by a free administration of fluid proves the diagnosis.

One ounce of water every one hour is the minimum requirement for the first 24 hours.

When unconsciousness is deep and C.S.F. pressure high, two pints of fluid a day are essential. When consciousness returns three pints may be given. Alternately with glucose water, milk may be given at this stage. Nutri-

tional needs will be satisfied by about forty ounces of milk. It should be given in divided doses not exceeding five ounces at a time.

The minimum total fluid needs of an adult in this country would be 3,500 c.c. If necessity demands that the total quantity be given by either the intravenous or parenteral route, and should glucose and normal saline be employed, there is a distinct possibility of an overdose of sodium chloride. The total sodium chloride intake should average between five and six grammes a day. Hence a limited quantity of normal saline should be used and the further fluid needs be supplied by the use of 5% glucose solution (without sodium chloride). Later, fruit juices, milk jellies, custard, etc., may be added to the daily dietry.

**The Bowels:**—Diarrhoea associated with restlessness is distressing. Correct it with Bismuth and opium. Constipation should be avoided as any straining at stool is likely to raise the intra-cranial pressure. A two ounce glycerine enema is more convenient than a large cleansing enema.

**The Bladder:**—Years of habit of a civilized life cause a man to seek evacuation of the bladder at certain intervals and in certain convenient positions. The forced recumbent posture is a real obstacle to many. There is apraxia. The patient does not empty the bladder because he does not know what to do. The distended bladder makes him restless and he may attempt to get out of bed to empty the bladder. Timely catheterization will ensure considerable comfort to the patient. When there is an incontinence a bidette may be fitted to a female patient and a large sized rubber tubing may be fixed over the penis in the male and secured in position by means of an adhesive tape.

**The Skin:**—Bedsore must be prevented by good nursing. A very restless patient may produce serious abrasions over knees, elbows and the heels as the result of constant movement and friction. These parts require to be protected by the tying of a bandage over a liberal pad of cotton wool.

Neglect of oral hygiene will lead to parotitis.

**Temperature:** A rise of temperature may be treated by tepid sponging. Rowbotham recommends intravenous injection of 20 grs. of aspirin if temperature cannot be controlled by

other means. To give aspirin intravenously it should be dissolved in alcohol. The Alcoholic solution is to be injected very slowly.

The operative line of treatment in cases of closed injuries of the head will be required in a small percentage of cases. (1) Thus a craniotomy of an exploratory nature may be indicated. The importance of early small exploratory holes is already mentioned. Sometimes such an exploratory operation may be much more extensive.

(2) An operation may be indicated for associated injuries such as wounds of the scalp or a depressed fracture.

(3) Some of the superimposed phenomena such as epidural haemorrhage, and tentorial herniation will demand a well thought out plan of action.

(4) Operative procedures will be required for some of the more late complications or sequelae of head injuries such as a sub-dural haematoma, cerebro spinal rhinorrhoea, post traumatic epilepsy, persistent vertigo of a labyrinthine origin, arterio venous aneurysm.

(5) Very rarely a purely palliative decompression operation will have to be done, either unilateral or bilateral, to relieve generalised oedema. In the past it was frequently employed to relieve intra-cranial pressure where symptoms and signs were not of a localising nature. A simple subtemporal decompression merely increases the cranial capacity temporarily. Within a short time a new equilibrium is established and the decompression becomes useless.

In fact the brain may bulge through the exploratory opening seriously impairing the function of the part of the brain involved in this process of herniation. In all such cases, where a palliative decompression is required, it should be done over a silent area. A left-sided sub-temporal decompression may end up in aphasia in a right handed person. It is best to ascertain from the nearest friends or relations whether a person is right or left handed before resorting to decompression. Another practical detail to be observed is that the relieving incision in the dura should not extend higher than the Sylvian fissure. Otherwise the lower end of the motor area will be endangered.

The details of equipment and technique of cranial and intra-cranial operations are so well known, as not to need any elaboration before the present audience.

It remains now to enumerate the complications resulting from the treatment employed.

- (1) Adherent operation scar.
- (2) Large sized cranial defects.
- (3) Retained foreign bodies introduced at the time of the operation such as silk sutures, cotton patties, unabsorbed muscle grafts, dead bone.
- (4) Broken lumbar puncture needle.
- (5) Post operative Cerebro-Spinal fistula.
- (6) Fungus cerebri.
- (7) Infections.

**The Convalescence:**—A proper management will reduce to a great extent the residual symptoms of head injury such as head-ache, dizziness, etc. For practical purposes it is best to divide convalescence into three periods.

**The First Period:**—This begins when lumbar punctures show that the intra-cranial pressure has returned to the normal level and has no tendency to rise again. During this period it is important to keep the patient in bed flat on his back. The importance of the position of the head has already been pointed out. The modern tendency is to shorten this period. In fact it should never be prolonged beyond a fortnight.

**The Second Period:**—Part of this period is spent in the hospital and part at home of the patient. Get the patient first to sit up in bed for increasing periods. After two or three days get him out of his bed and encourage him to do so whenever he wants. This demonstrates to him and to his relations that he can now be active at home and yet have no symptoms. He should not be encouraged to have breakfast in bed. He can now go home being fully assured that he will have no mental trouble in spite of his being informed to the contrary by well meaning but disgustingly stupid visitors and friends. He is advised to spend about nine or ten hours in bed whether he sleeps all that time or not. He is encouraged to read, or occupy his time in a suitable hobby. Moderate exercise is recommended. The importance of the regulations of bowels is stressed. If post

neurotic symptoms are to be minimised, the patient should see as little of his doctor as possible. He must begin to depend upon himself to find out whether he is over exerting himself and then correct himself accordingly. If possible insurance agents, lawyers and fussy friends should be excluded from contact with the patient during the period.

This period need not be extended beyond a month. In fact the patient should be encouraged to cut down the extra period of rest in bed and, prepare himself for his daily occupation. The real trouble arises when the patient is non-cooperative and various problems of a medico legal interest arise in respect of compensation. This part of the subject is so vast that it cannot be discussed at this juncture.

As a final parting advice the patient is told not to indulge in alcohol for the rest of his life, not to go out in the open sun, not to dive head first into water and not to go on to high places without adequate protection.

### SUGGESTED SCHEME FOR INVESTIGATING CASES OF HEAD INJURY.

Name, etc.

(Retain every case of head injury unless definitely trivial. Take a signed statement from the patient should he wish to go away against medical advice.)

Degree of shock present:—Mild, Moderate, Severe.

		S		
Colour	B.P.	—	Pulse	Temp.
		D		

Respirations:—Frequency Character.

Odour of breath:—Diabetic, Uraemic, Alcoholic. (Treat Shock if present).

(If shock is not present or as it is being treated, note down the history of the accident as given by the patient or by others.)

Name and address of the person giving the history of the accident.

Type of Accident:—Automobile, Tram, Train

Time of Accident:—Day Hour.

Place of accident.

(If no shock is present, or after shock has been treated look for evidence of injuries.)

## (A) Evidence of extra cranial injuries.

- (1) Limbs:—Fracture, open wounds.
- (2) Abdomen:—Rigidity, Liver dullness, Shifting dullness, Superficial reflexes.
- (3) Chest:—fracture ribs, Surgical emphysema, hamothorax pneumothorax.
- (4) Spine:—Irregularity over the Spine  
Flaccid paraplegia. Brachial plexus injury.

(Shave head if necessary).

## (B) Evidence of injury to scalp and face

- (1) Lacerations.
  - (a) Scalp
- (2) Tumefactions
  - (b) Face
  - (c) Conjunctiva
  - (d) Temporal muscle
- (3) Depressions.
  - (a) Orbital
- (4) Discolouration
  - (b) Conjunctival
  - (c) Retro-mastoidal

## (C) Evidence of Cranial injury.

- Fracture
- (1) Depressed.
  - (2) Fissured.

## (D) Evidence of simultaneous Cranial and intra-cranial injury:—

- (1) Blood through orifices or under galea.
- Escape of (2) C.S.F. through orifices or under galea.
- (3) Air, Surgical emphysema, aerocele.
- (4) Brain substance, through orifices or open wounds.

## (E) Evidence of Intra-cranial injury (non-localising).

## (1) Degree of Unconsciousness:

- (a) Comatose—No response to painful stimuli, e.g., pressure on testes, pricking finger tips, pushing the jaw forward etc.

Jaw—dropped. Eyes half open.

Corneal reflex—Swallowing reflex—Tendon reflexes—Retention of urine,

## (b) Semicomatose

Responds to painful stimuli.

Eyes closed.

Swallowing reflex—Corneal reflex + Deep reflexes + Bladder empties reflexly.

## (c) Confusion

(Test for orientation from point of time, place and person).

- (i) Severe—patient is inaccessible. Just responds to simple commands e.g. "Put out your tongue."

- (ii) Moderate—does not realise surroundings, responds to simple questions, e.g. "Where do you live?" "What is your name?"

- (iii) Mild:—Coherent conversation possible.

Not completely oriented yet, e.g. keeps repeating a question already answered.

## (2) Restlessness.

## (3) Delirium.

## (F) Evidence of intra-cranial injury (localising)

## (1) Fore-brain damage:—

- (a) Convulsion, movement,
- (b) paresis or paralysis,
- (c) Special centres e.g. speech.

## (2) Cranial Nerves

## (3) Posture (Red Nucleus, Deiter's Nucleus)

## (4) Rigidity or flaccidity in paralysed limb (condition of cortex),

## (5) Evidence of Mid-brain damage.

(a) Pupils	Left	Right
Size	...	...
Reaction	...	...

## (b) Abnormal position of eyes

## (c) Incoordination of eye movements

## (d) Restriction of movements of the eye

## (e) Skew deviation

## (f) Squint

## (g) Nystagmus.

## (6) Evidence of hind-brain damage

## (a) Pulse. (b) B.P. (c) Temperature.

## (d) Respiration (frequency, type).

## (e) Vomit,

(Repeat all these observations every half hour or less frequently with special reference to level of unconsciousness).

(Repeat observations until patient is fully conscious.)

(Full consciousness begins where post traumatic amnesia ends.)

Note Duration of Post traumatic Amnesia.

(As patient regains consciousness and begins to narrate the events leading up to the accident, keep careful notes of the statements from time to time to enable a final check up on the length of retrograde amnesia).

Make note of retrograde Amnesia, its presence and its duration.

(A very smooth narration is generally a result of coaching from interested quarters).

(If patient does not regain consciousness after 12 hours do a first lumbar puncture).

#### 1st LUMBAR PUNCTURE.

- (1) Pressure of C.S.F. as measured by a manometer.
- (2) Naked eye characteristics.
- (3) Evidence of R.B.C. (microscopic) number of cells per one cubic m.m.
- (4) Quantity of fluid removed to bring C.S.F. pressure to lowest normal level. (If first tap is heavily stained with blood do a second lumbar puncture after 16 hours. Repeat lumbar punctures every 4 hours until C.S.F. is clear, repeating same observations.

If first lumbar tap is free from blood do a second lumbar tap after 18 hours, even if case has recovered.)

#### 2nd LUMBAR PUNCTURE.

(If second lumbar tap shows a high intra-cranial pressure start dehydration therapy—50% glucose or sucrose.

After 24 hours do a 3rd Lumbar tap and note manometric pressure. If C.S.F. pressure is high, repeat a lumbar tap every 12 hours until C.S.F. pressure remains normal.)

#### NATURE OF SURGICAL MEASURES EMPLOYED.

Daily notes should emphasise (a) Level of consciousness, (b) post traumatic Amnesia, (c) retrograde amnesia, (d) headache, (e) pulse,

(f) temperature, (g) respirations, (h) blood pressure, (i) C.S.F. readings, (j) Pupils, (k) reflexes, (l) sleep, (m) delirium, (n) restlessness, (o) vomiting.

#### Accessory examinations

- (1) X-Ray—Plain, encephalography, ventriculography.
- (2) Ophthalmoscopy.
- (3) Auroscopy.
- (4) Electro-encephalography.

#### EVIDENCE OF ASSOCIATED DISEASES

Particularly Syphilis and Arterio-sclerosis.

**Diagnosis** (a) Pre-operative, (b) post-operative, (c) Full diagnosis, e.g. (a) Head injury Type 3(b); (b) haematoma left parietal region, (c) fracture left parietal region, (d) probable contusion left parietal lobe, (e) traumatic subarachnoidal haemorrhage.

#### POST MORTEM NOTES

**FOLLOW UP:** Headache, giddiness, nervous symptoms, epileptic seizures medico-legal complications.

#### DISCUSSION

**R. Mahadevan, Vizagapatam,** wanted elucidation on the following points:—

- (I) When a patient is brought unconscious with a recent head injury, one sometimes hesitates to adopt dehydration therapy, for fear of restarting a haemorrhage that may have just stopped. Are there any guides to decide when it is safe to institute methods of dehydration?
- (II) In a patient stuporose or unconscious with head injury, the pupillary changes sometimes occur in bizarre fashion. At one moment one of the pupils is moderately dilated while the other is normal, but after a very short interval, the pupils show a reverse condition without any obvious change in the clinical state of the patient. Such changes have occasionally been demonstrated to the students. What is the significance of such pupillary changes? I may add that the few patients that showed such pupillary changes eventually did well. In no such case was any operative interference required.

He made the following statements as being worthy of particular mention;—

- (1) All depressed fractures of skull in the adult are compound.
- (2) Sulphathiazole is not to be used for cerebral wounds. "It is the only one of the sulpha group which is dangerous if applied to the brain surface, since it causes fatal fits when it is put in too high a concentration in contact with the cerebrospinal fluid i.e. it cannot be freely sprinkled on the brain surface"—(Geoffrey Jafferson, 1945).
- (3) Some at least of the deaths in patients unconscious with head injuries, are possibly due to insufficient feeding. At any rate insufficient feeding tips the scale against the chance of recovery in some cases. The feeding of unconscious patients must be in the hands of well trained nurses. Intragastric drip feed has a place in feeding these patients; the feeds consisting of milk, egg-flip, fruit-juice, glucose water, normal saline, plain water, etc.
- (4) The need for a thorough general examination of all patients with head injuries and particularly so when they are brought in unconscious, cannot be sufficiently stressed. A slackness in general examination may result in other serious injuries being overlooked—injuries serious enough to be the ultimate cause of death. -I know of a case where an unconscious patient had not only a head injury but also a severe fracture of the jaw. This fracture was missed and death resulted from asphyxia caused by the tongue falling back.
- (5) In dealing with compound depressed fractures of the skull, if the dura is intact, it is usually wise not to open it for further examination of the state of structures underneath. However, there are conditions, where, even if the dura is intact, it may have to be opened. They are:—
  - (i) if there is no pulsation of the brain;
  - (ii) if there is dark discolouration underneath suggesting heamorrhage.

The following brief case reports testify to the well-known aphorism that "No head injury is



Fig. I

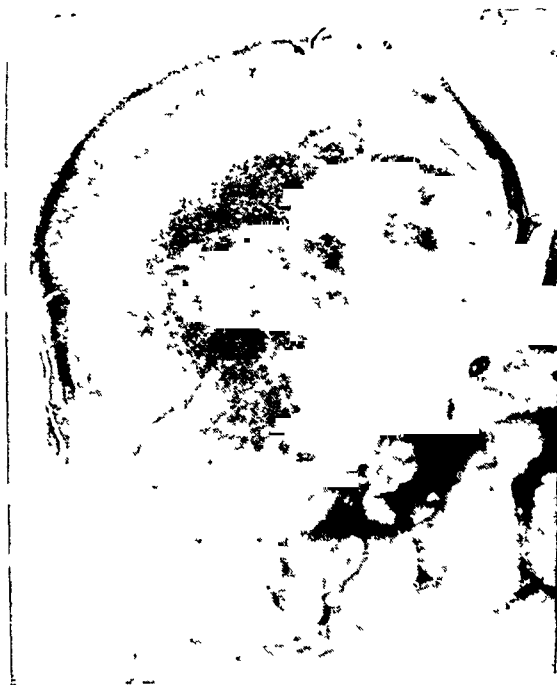


Fig. II

Figures I and II show a severe compound depressed Fracture of the skull. Patient was brought unconscious and had right sided hemiplegia. Scalp wound was excised and depressed fragments removed. He was unconscious for eleven days, but ultimately completely recovered,

so serious as to be despaired of, or so trivial as to be neglected":—

- (1) A man of 35 had a direct hit on the head with a stick resulting in a severe compound fracture of the skull (Figs. 1 and 2). He was brought to hospital 24 hours later deeply unconscious. There was hemiplegia of the right side. The depressed fragments were removed after debridement of the wound. He was unconscious for 9 more days and on the 11th day of the injury began to slowly regain consciousness. The hemiplegia also gradually disappeared and he was discharged about 7 weeks after admission having reached a practically normal state.
- (2) A boy of 8 was admitted 27 hours after an accidental direct hit with a pick axe. A large amount of brain matter was protruding through the wound, and the brain was pulsating. The boy was, however, quite conscious and looked fairly comfortable. The scalp was shaved, sloughing brain matter removed, wound dusted with sulphonamide powder and covered over with flavine gauze. He was given sulphonamides by mouth and he ultimately recovered. Culture of the brain matter showed heavy contamination with bacillus pyocyaneus, gram positive cocci and gram negative diplococci.

In another case of a similar nature however, a child after a period of recovery, developed meningitis and was taken home in a moribund condition. The organisms in this case were probably sulphonamide resistant. Penicillin might have saved the child, but this unfortunately was not available at the time.

#### REFERENCE.

GEOFFREY JEFFERSON—Head Injuries—  
Medical Annual  
1945—pp.135-139.

V. L. Suryavanshi with his experience of a large number of cases of different types of fractures of the skull with various symptoms, gave it as his general impression that in the face of even alarming signs and symptoms it may be possible to save a patient with cerebral compression. He said that all patients with

similar injuries of the skull and the brain may not show identical symptoms showing that the brain does not suffer the same physiological damage in all cases. Referring to the question of opening the durameter Mr. Suryavanshi said that if the dura is found to be tense, if the pulsations of the subjacent brain are neither seen nor felt or if it looks purple indicating a haemorrhage underneath, it should invariably be opened. Where the Surgeon is in doubt as to the exact nature of the trauma and if the general condition of the patient be not grave, it is better in his opinion to trephine rather than go on with hypertonic intravenous saline, lumbar punctures, etc.

V. P. Mehta: Stressed on the need for propaganda to prevent cases due to automobile and other accidents. He referred to the value of pupil and consciousness charts, pupillary changes alone being not always reliable in diagnosis.

Lumbar puncture, he said, should be carried out in all cases and in his series where the C.S.F. tension was recorded with the aneroid manometer the highest recorded was 80 more than normal while the lowest was 40; therapy should aim at restoring tension to normal.

No case of chronic C.S.F. rhinorrhoea has been recorded in a series of 400 cases analysed by him.

R. Nagendran, Mysore, gave a brief outline of the treatment of head injuries in battle casualties.

The Army Medical Department had provided separate centres for treating head injuries.

A person receiving injury to the head was treated by the Regimental Medical Officer by cleaning of the wound and the application of Sulphonamide powder and bandage; A.T. Serum 1500 units was given by injection. In the forward Surgical Unit or the Casualty Clearing Station, the wound was re-examined to see if there was bleeding. Bleeding points were ligated. The wound was dressed with Sulphonamide powder and dressed with gauze and bandage. The wounded person was evacuated by ambulance, ambulance train or by air to the 'Head centre'. Head injuries stood air evacuation very well indeed.

At the 'Head centre', the skull was x-rayed in different positions according to the needs of the case. The head was shaved and under local infiltration anaesthesia, the wound margins were excised. Opening into the cranial cavity was made by suitable trephine holes. Bleeding vessels in the dura were ligated. By means of a sucker all soft brain tissue was removed. No special attempt was made to remove Foreign bodies if any. Then Calcium Penicillin with Sulphonamide was sprayed as a thin foam over the brain and the skin closed as a Primary Closure. The patient was nursed in the half sitting position. Sutures were removed on the 4th or 5th day and in most cases healing took place satisfactorily.

In the Central Mediterranean Theatre Indian patients with large trephine holes in their skull were sent to 15, Scottish General Hospital in the Middle East for closure of the skull defect.

Primary closure of the skull defect was tried successfully in some cases by the use of acrylic plates. These plates could be easily moulded on the skull and could be anchored to the pericranium by holes made on the periphery of the plate. To prevent the formation of a haematoma under this plate, the dura was stitched up to a hole in the centre of the plate, thus avoiding a potential space between the plate and the dura.



# THE TREATMENT OF BURNS WITH SPECIAL REFERENCE TO THE - AETIOLOGICAL FACTORS IN SHOCKS AS IT OCCURS IN BURNS

BY

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The question of the adequate treatment of burns, although of great importance in peace time, especially in industrial areas, has assumed very much greater importance of recent years, owing to the enormous number of cases of burns which have arisen as a result of the war, both in the fighting forces, and among the civilian population of the combatant countries.

The result of this has been a fillip to research into the pathology and treatment of burns of all types, and their associated complications. There has also been publication of an immense quantity of literature describing the results of this research. Prominent in that literature have been descriptions of investigations into the most important factors in the causation of deaths following burns, namely surgical or oligæmic shock. It is perhaps in this direction that the most important practical results have been achieved. Progress has been made, and increased understanding obtained, of the aetiology and mechanism of this constant accompaniment of burns. Factors in the production of oligæmic shock, which but a few years ago could only be regarded as theories, have since been placed on a sound scientific basis, and may now be regarded as matters of ascertained fact. An attempt will be made in this thesis to present in a compact form the present state of knowledge with regard to burns and their treatment, to pay special attention to the mechanism of production of shock associated with burns, and to describe the most recent methods of prevention and treatment of that condition.

For this reason undue space will not be devoted to long descriptions, or classifications and types of burns, nor to the highly specialised subject of burns arising from such causes as exposure to X-Rays and chemicals such as mustard gas and lewisite; nor to dealing with theories and practice which have now become, or should have become obsolete. These will

only be included when they have some bearing on the practical issues involved.

## THE CAUSES, TYPES, AND CLASSIFICATION OF BURNS.

Burns in general are caused by the application of heat, or of certain chemicals, to the tissues of the body. Increased industrialisation, the use of electricity, and the introduction of the internal combustion petrol or oil driven engine, have resulted in a great increase in the number of cases of burns in civil life, whilst in the time of war to these are added incendiary bombs, certain types of which contain chemical substances which ignite and burn at very high temperatures, often setting fire to buildings, with obvious risks to their occupants. Others contain phosphorus, which ignites spontaneously, and continues to burn whilst it is in contact with the atmosphere. If any of the combatants in future wars decide to employ chemical warfare, burns from mustard gas lewisite, or some similar chemical may become commonplace. Flame throwers of various types are already in use, and add further horrors to modern warfare. With the exception of the war gases, the effects on the human body of all these different modes of causation of burns are identical, so that time and space will not be wasted in describing them individually.

**Classification of burns.** It is customary to divide burns into major and minor burns, although any such classification is purely arbitrary. The placing of a burn into one or other of these categories depends broadly speaking on two factors. Firstly the extent of the burn, and secondly its depth or degree. As a general rule the extent of a burn is of more practical importance than its depth, as the degree of shock depends very largely on this factor. It therefore has a very important bearing on the prognosis of the individual case. The extent of a burn is as a rule fairly easy to assess with sufficient

accuracy for practical purposes, but for statistical records more accurate methods have been devised, notably by Du Bois and Du Bois, (1) who in 1915 introduced a method of assessing the total surface area of the body, and of any individual part of it, employing certain measurements and constants which they published in the form of a Table.

The academic classification of burns with regard to their depth, is that of Dupuytren, who classified them into six degrees according to the tissues involved. Dupuytren's classification, although useful theoretically, has now given place to simpler classifications, with a more practical application. The essential point about the degree of any given burn, is whether or not the burn has destroyed the whole skin. From a practical point of view, and from the aspect of successful treatment, it is therefore most convenient to adopt the classification suggested by Wakely (2) and to divide burns into two degrees only\*. Any further future reference in this thesis will be to this classification.

1. Burns involving partial skin loss. These include the first and second degree burns of Dupuytren's classification.
2. Burns involving total skin loss, no matter what additional structures are involved. These include the remaining four degrees of Dupuytren's classification.

Most burns of any consequence show areas in which there is partial skin loss, and others where the whole depth of skin has been destroyed. In many cases it is difficult to estimate in the early stages whether a burn is of the first or second degree, although the recognition of fat may be of assistance, but an attempt should always be made, as future progress, prognosis, and treatment will largely depend on it.

### ASSOCIATED COMPLICATIONS AND THEIR AETIOLOGY.

As in other types of trauma, morbidity and mortality from burns arise not so much from the local injury, as from the associated complications of that injury. The usual complications and associated conditions of burns are, in order of their appearance, which is not of course the order of their importance:

- (i) initial shock.
- (ii) secondary shock.

(iii) post-traumatic hypertension

(iv) toxæmia, with which may be associated sepsis.

These conditions, in greater or less degree, are seen in most burns, of any magnitude. Other rarer complications which may arise are various respiratory lesions, duodenal ulcer, and jaundice, whilst scarring is a common sequel.

(i) **Initial shock.** Shock is no single entity. Differentiation between initial shock arising almost immediately after an injury, and secondary shock, usually manifesting itself within two hours of the injury has long been recognised. In their turn neither of these two conditions is a separate entity and in the case of initial shock various authors have laid stress on different aspects of the condition and have given different names to a group of conditions which are certainly very closely allied. The term in most common use is primary shock. McMichael (3) lays stress on the nervous element in its production and prefers the name of neurogenic shock. The Medical Research Council (4) in "The treatment of Wound Shock" describe a condition, vaso-vagal collapse, which usually comes on soon after injury, but may occur subsequently, particularly on the assumption by the patient of the upright posture, or as a result of fluid loss or painful manipulation or dressing (5). It is probable that all these conditions, if not identical, are very closely associated in their aetiology. The sequence of symptoms has been most closely studied following venesection in man.

**Clinical features.** The clinical features are well-known. The patient feels faint, with an alternating sensation of heat and cold. Sometimes vomiting occurs, and very rarely, convulsions. There are signs of lowered blood pressure. At first the pulse is fast, feeble, and of poor volume, but in later stages the pulse rate usually falls to 50-60 per minute. The systolic blood pressure may fall in mild cases to 80 m.m. of Hg. or even less, especially in cases which are associated with a fair amount of hæmorrhage.

Mild degrees of primary shock usually pass off if the patient is kept flat, and more severe cases respond well to treatment by the application of warmth, and relief of pain with

morphia. Of 270 cases of minor burns treated by the present writer following an air raid in 1940, 127 exhibited symptoms of primary shock which passed off with no treatment other than warmth, hot drinks, reassurance, and rest in a recumbent posture.

Nevertheless primary shock has a small mortality, and may account for 2 or 3 per cent. of all deaths from burns and scalds. (5).

**Aetiology.** The precise aetiology of primary shock is still obscure. In some cases the psychological aspect is predominant. In others the condition seems to be the consequence of severe vaso-motor upset caused by the reception of multiple painful nervous impulses from the injured area, and resulting undue stimulation of the sympathetic nervous system which causes constriction of the arterioles of the skin and splanchnic area, but dilatation of the vessels in the skeletal muscles.

It is fairly generally accepted that the fall of arterial pressure is not directly the result of reduced cardiac output, but is due to the vaso-dilatation in the skeletal muscles.

Repeated investigations have revealed no abnormality in the blood chemistry or in the sedimentation rate.

The degree of primary shock depends in part on the extent of the area involved in the injury, and an extensive superficial burn causes more primary shock than a small deep one.

(ii) **Secondary Shock.** Primary shock may pass into a condition of secondary shock, also known as traumatic shock, wound shock or oligæmic shock. On the other hand secondary shock may develop quite suddenly an hour or more after a burn or other injury is sustained.

**Clinical features.** In established shock the following signs are exhibited. The patient's skin is pale, cold, and clammy; the pulse is rapid and thready; respirations are shallow and fast; the temperature is sub-normal; urinary output is diminished, and the arterial blood pressure may show a steady fall, or a pronounced and rapid one. The venous pressure is low. Although the skin is generally very pale, cyanosis in the lips, lobes of the ears and nails may indicate the sluggish state of the circulation. The patient is usually quite

clear mentally, but the expression is usually anxious, and in progressive cases the patient passes eventually into a state of apathy which is followed by death.

Although established shock is easy to recognise, in the early stages of the condition the outward appearance of the patient may be misleading on casual examination, but careful clinical observation will, even in the early stages, reveal a rapid pulse of poor volume which precedes any great fall in blood pressure. As the severity of the condition increases, the blood pressure falls profoundly and the pulse may become imperceptible at the wrist.

Finch (6) says that secondary shock is dangerous if the pulse rate is 120, the systolic blood pressure 60 mm of Hg. or less, and the blood volume 35—50 per cent. below normal.

**Aetiology and mechanism.** The problems of secondary shock in cases of burns are somewhat different from similar problems in other branches of casualty surgery, since shock complicating burns is not as a rule accompanied by much hæmorrhage. Although the subject of much dispute in the past, it is now generally agreed that secondary shock in burns is due to the great loss of plasma from the burned area, and resulting oligæmia (7).

At first, fluid rich in electrolytes, and later fluid rich in plasma protein, escape from the surface of the burn, and, which is more important, into the tissue spaces of the whole of the area involved, through a local increase in capillary permeability (8).

The amount lost from the surface is small in comparison with that lost into the tissues. The condition is therefore really the result of a transfer of fluid from where it ought to be to where it ought not to be. Dunphy et al. (9) in animal experiments to investigate bio-chemical changes in the lymph and serum following burns, came to the conclusion that there is no increase in capillary permeability in regions of the body distant from the burn, and this was later confirmed by Glenn et al. (10).

The state of abnormal capillary permeability which is responsible for the plasma loss in burns commences within an hour or two of the injury and ordinarily continue for from 24 to 40 hours, after which it becomes progressively less (11). An appreciation of this fundamental principle is essential from the point of view

of treatment and its practical application will be considered in the Chapter on Treatment.

Animal experiments have shown that plasma loss is greatest in second degree burns and amounts to over 70 per cent. of the total blood volume in cases where one sixth of the body surface has been involved (12). If fluid other than whole blood is removed from the circulation, the blood which remains will become thicker, that is, there will be a relative increase in the number of corpuscles. This haemo-concentration is greater in shock due to burns than in shock due to other kinds of injury, and estimates of the degree of haemo-concentration provide a useful, though not entirely reliable index of the effects of treatment. The concentration of red cells may reach a capillary count of 9 million cells per cubic millimetre.

The loss of plasma is manifested clinically by a fall in blood pressure, although the fall in blood pressure occurs when the compensatory mechanism of the body which maintains the circulation commences to fail.

The circulation of blood in the human body is maintained by three factors, the force of the cardiac muscle contraction, the resistance in the peripheral vessels, and the viscosity of the blood. Interference with these factors is liable to produce a fall in blood pressure and ultimately circulatory collapse, and interference with any one of them produces compensatory reactions in the others. When the volume of blood is considerably reduced, either by haemorrhage or by exudation of plasma into the tissues, the venous side of the circulation is at first affected more than the arterial. Pressure in the great veins near the heart is lowered which results in imperfect filling of the heart and consequent reduction in its output. (Starlings law).

This is followed by decreased pressure in the carotid sinus, with consequent acceleration of the pulse and compensatory sympathetic stimulation, with vaso-constriction, sweating, and skin and visceral pallor.

This mechanism becomes operative when the systolic blood pressure is reduced to about 80 m.m. Hg. and if the blood pressure is allowed to become reduced by another 20 m.m. Hg. collapse of the circulation ensues (13).

The relation between the clinical condition and the degree of blood volume reduction has

not yet been perfectly defined, but it is known that a reduction of 25 per cent. in blood volume may be associated with only slight symptomatic disturbance. Losses greater than this are likely to produce a considerable decrease in blood pressure and when 50 per cent. or more of the blood volume is lost the fall in systolic blood pressure is often to below 60 m.m. Hg. (14). More accurate methods, the result of further investigations, may at some future date result in the measurement of blood volume or the specific gravity of the peripheral blood furnishing a reliable indication of the degree of shock in individual cases.

In cases of secondary shock, if the lost blood volume is restored quickly and completely the symptoms described above pass off, and recovery results. If, however the condition has been left untreated for several hours, restoration of the blood volume may have a disappointing result, and recovery not take place. In these cases haemo-concentration and other signs of shock persist until death supervenes, which is usually between 20 and 30 hours after the original injury.

The causes of this irreversible circulatory failure are still the subject of much discussion. It is possible that prolonged anoxia damages the vital centres in the medulla. Damage to the cardiac muscle, the result of poor coronary blood supply, may also be a contributory factor. Wiggers (15) is of opinion that there might be some as yet unidentified factors such as changes in the adrenal cortex, translocation of potassium, or some other unknown cause of vaso-motor failure.

Besser (16) supports the view that the adrenal cortex protects the organism against shock on the grounds that removal of the adrenals, or even adrenal insufficiency produces a condition similar to shock. There is also increase of cortical hormone in the urine of shocked patients, and discharge of lipid granules from the cells of the adrenals in conditions of shock and circulatory failure. He concludes that the adrenal cortex regulates the electrolytic balance, permeability of the capillary walls, and consequently the volume of circulating plasma. The function of the adrenals in the causation of shock is, however, still uncertain, although further research may well show that they are the key to the whole problem.

On the basis of findings up to the present, however, Desoxycorticosterone acetate has been used clinically in a small number of cases (17). It appears to be of little use in established shock, but is said to prevent the onset of post-operative shock if given in the pre-operative period and continued for two days afterwards. The expense of these preparations at present precludes their trial on an extensive scale.

It was formerly thought by many that destruction of protein and absorption of histamine bodies was responsible for shock. It is generally agreed that the onset of shock may coincide with the release of a tourniquet, which apparently must result in the setting free of some toxic substance into the circulation. Perfusion experiments with blood from an injured limb, however, have not given the same results. Post-mortem appearances in death following known histamine shock show intense congestion of the intestines whilst in traumatic shock the intestines are bloodless. The evidence for histamine as the substance responsible for the onset of shock is therefore far from convincing.

From the foregoing it will be realised that although much research and analysis of chemical and pathological data has been carried out in connection with the aetiology of secondary shock, much still remains to be done before we are able to say that its causation is so completely understood that its treatment can be formulated on a completely rational basis.

(iii) **Post-traumatic hypertension.** It has already been indicated that blood pressure readings are of vital importance in the estimation of shock. They are, nevertheless, not to be implicitly relied upon, as cases are not infrequent, where a patient has sustained severe burns and is undoubtedly in a state of shock, yet the systolic arterial blood pressure is comparatively normal, or even raised (18). Such cases often develop acute circulatory collapse later, and frequently with little or no warning. In some instances the syndrome may occur in patients who had a high blood pressure before they became casualties, but in others there is little doubt that the relatively high blood pressure is due to vaso-constriction occurring simultaneously with the decrease in blood volume as a result of hyper-secretion of adrenalin. It follows that in severe burns

complete reliance should not be placed on the blood pressure level, but rather on the nature and severity of the injury.

(iv) **Toxaemia:**—In cases of burns, particularly those who for some unavoidable reason have not received adequate treatment in the early stages, a condition of intoxication is liable to occur from 48 hours to 10 days after the injury. The onset is usually insidious, but may be fulminating. There is often vomiting; the patient becomes irritable and distressed, complaining of headache and loss of appetite, with which are associated a high temperature and a rapid pulse. Urinary output falls, stupor develops, and may gradually deepen into coma. The temperature continues to rise, and death often occurs with hyperpyrexia.

In many cases, bacterial infection of the burn has undoubtedly taken place in the early stages, and in these cases the actual burned area becomes frankly septic, and exudes seropus. But in others sepsis can be excluded with reasonable certainty, and these cases are very difficult to account for. Many workers, including Davidson, (19) have suggested that the condition is due to some toxin formed at the site of the burn by the formation of a high protein derivative resulting from autolysis of the injured cells.

In 1938, Wilson, MacGregor, and Stewart (20) described post-mortem degenerative changes in the viscera and particularly in the liver which lent weight to this hypothesis, although they also pointed out that toxaemia was more common and severe in burns treated with tannic acid than in those treated by other methods.

More recent work, however, indicates that severe necrosis of the liver after burns probably occurs only with tannic acid treatment and results from absorption of tannates (21). The evidence for toxic absorption from burns in general has therefore to a certain extent been discounted. At the same time it must be conceded that occasionally these symptoms have occurred with forms of treatment other than by tannic acid. Treatment of toxaemic symptoms in the absence of obvious sepsis therefore remains to a certain extent empirical.

The prevention of septic toxaemia lies in adequate treatment in the early stages, and this is all the more important since if sepsis becomes well marked, septicaemia and pyaemia often supervene.

The introduction of chemo-therapy has reduced the incidence of septic toxæmia, but it still remains a serious contributory factor to deaths from burns, especially in cases where, from unavoidable reasons, prompt and adequate treatment has not been possible.

**Undue scarring and contractures:**—These are complications which in the majority of instances are preventable by proper and careful treatment, but still occur far more frequently than they really should. The condition may vary from the mere presence of a puckered unsightly scar, to severe deformity the result of muscles, tendons and joints becoming fixed in an abnormal position.

There is little difficulty in the prevention of undue scarring in burns with only partial skin loss. If there has been extensive and total skin loss, however, severe scarring is likely to result unless the burned area is skin grafted immediately it becomes covered with granulation tissue. Sepsis if allowed to develop leads to the formation of further connective tissue arising from the inflammatory processes.

The mechanism of the production of contractures varies, and it is not only in burns in which muscle has been actually involved that severe contracture is liable to occur. After burns, or indeed any other form of trauma, joints tend to assume the position of greatest ease. At the same time muscles adjacent to a burned area tend to contract thus releasing some of the tension on the burned surface. Such a muscle or tendon may become fixed to its surrounding sheath by the organization of even a slight exudate, and unless steps are taken to prevent it they will become fixed in an abnormal position. In other cases muscles and tendons which have long been fixed in an abnormal position, though they may not have been damaged in the original injury, become permanently shortened. In more extreme cases of this nature, the ligaments on the flexor aspects of joints may become shortened and in some instances intra-articular changes may even take place. These latter conditions, although they should really never arise, are extremely serious if they do, as they obviously cannot be cured by any cutting away or other treatment of the overlying scar, and restoration to normal function becomes impossible. The occurrence of these catastrophies is probably more frequent in burns than in other forms of trauma, since burns, owing to the

relatively greater interference with cell nutrition from venous and lymphatic thrombosis take much longer to heal than raw surfaces of similar extent caused by other forms of injury. The necessity of bearing this in mind during the early stages of treatment needs no stressing. The mere covering of a burned area with a newly formed skin surface should not be the criterion of cure, and no end result should be regarded as satisfactory unless there is complete restoration of function of the injured part.

**Respiratory lesions:**—In burns involving the anterior aspect of the trunk and face, and especially if the patient has been enveloped in flames, or has breathed very hot air following explosion in confined spaces, bronchitis, broncho-pneumonia, and pulmonary oedema are liable to ensue. There may also be inflammatory changes and even sloughing of the linings of the upper respiratory passages.

These complications, when they occur, are all of serious import, and the prognosis is exceedingly grave.

#### General Principles of Treatment.

For purpose of description of methods of treatment it is convenient to classify burns into major burns and minor burns, although such a division is of course only arbitrary. The following definitions cover the essential points.

Minor burns are those in which the burn is of the first degree. Not more than one per cent. of the body surface is involved, that is in the adult an area corresponding to about the area of the palmar surface of the hand, or about 28 square inches.

Major burns include all burns involving more than one per cent. of the body surface, and all second degree burns, that is, burns in which the whole thickness of skin has been involved. Most burns of the face, hands, and limb flexures should be regarded as major burns, irrespective of their degree.

**First Aid Treatment.** The most important object of first aid treatment in the case of burns in general is to prevent shock. In major burns no attempt should be made to diagnose the extent or degree of the burn. The patient should be reassured, kept warm, given warm drinks, and sent to hospital on a stretcher with as little delay as possible. If the affected area

is exposed it should be covered with a clean or preferably sterile dressing. The application of any preparation such as ointments, cold tea, oil, flour, etc. does not help the patient and adds considerably to the difficulties of the surgeon later.

In minor burns the same general principles apply, but hospital treatment will not be necessary and the patient can be treated by a doctor, either at home, at a surgery or dispensary, or in an O.P. Department.

**Minor burns** For any except the slightest of burns, a hypodermic injection of morphia is helpful. The burn should then be thoroughly cleansed with gauze swabs wrung out of sterile saline. Blisters should be opened with sterile scissors. Further treatment is then a matter of individual choice, and a whole range of jellies, ointments, and other preparations is available.

A solution of picric acid was formerly a great favourite in the treatment of burns, and is still in very common use in first aid posts and factories.

This drug reacts with the albumens of the burned surface and forms a slight eschar. It has the great disadvantage that it is liable to set up a condition of dermatitis in the skin surrounding the burn, and cases have been reported in which absorption and reaction to picric acid have resulted in the death of the patient. The present writer has seen many cases of dermatitis of a most intractable character following the use of picric acid and consequently gave up its use as far back as 1923.

Much to be preferred is to cover the burned area with one of the many coagulant jellies, of which triple dye jelly, (Gentian violet 1%, Brilliant green .1%, euflavine .1%, with 5% sulphadiazine in a water soluble base) is probably the best. This jelly, which should be liberally applied on two separate layers of gauze, causes coagulation and produces a soft, pliable eschar. The burn should be inspected on the second day, and if satisfactory the dressing should be left undisturbed until the separation of the tan after 12 to 14 days. If moist areas are found after 48 hours, the overlying gauze is cut away and fresh jelly applied. If fresh blisters develop they should be cut open and the raw surface treated in the same way.

Tannic acid and other burn jellies are also used, but in the experience of the writer, none of them is as satisfactory as those containing the aniline dyes.

Colebrook has obtained good results from a sulphonamide cream designed to prevent sepsis of the burned area and which is easily removable should more complete treatment in hospital prove necessary.

The treatment of superficial burns with micro-crystalline sulphathiazole has been carried out in the U.S. Navy Medical Corps. The powder is applied with an insufflator the burn having been previously thoroughly cleansed. The burn is then covered with sterile gauze and the whole tightly bandaged. Dressings are renewed every third day.

Recently the use of paraffin wax as a treatment for burns has been resuscitated by Lt.-Commander R. C. Pendleton (22) of the U.S. Navy Medical Corps. A mixture of paraffin wax, vaseline cod liver oil, and sulphanilamide, with traces of camphor, menthol and eucalyptus oil is sprayed on to the burned area from a flit gun. No bandage is applied. The wax film is washed off the burn daily with warm water, and renewed. The burn is not cleaned before the wax is applied, although it may be dusted with sulphanilamide powder.

The present writer in 1924 treated a series of over a hundred cases of minor burns by the application of Paraffin No. 7, which is a preparation of paraffin wax with a melting point of 48 degrees Cent., and has used the same method of treatment in suitable selected cases regularly since.

The treatment is suitable for first degree burns not too large in area, but the presence of patches of burning of the second degree is not a contra-indication where these are not too large.

The burn is first cleansed with warm water and afterwards swabbed with 1 in 1000 acriflavine solution. It is then carefully and thoroughly dried by dabbing with plain sterile gauze. The wax, which has been previously melted in a water bath is then painted on with a soft brush. A fair sized shaving brush is most convenient since it is preferable to get the wax applied as quickly as possible. The first coat is allowed to become hard, which takes place

in a few seconds, and a second coat is applied. A third coat is applied in the same way and finally the whole covered with sterile wool and loosely bandaged. After 24 hours the dressing is removed, when it will be found that the wax has been lifted from close contact with the burned surface by the exudation of serum, and can easily be removed with forceps. After drying, a fresh wax dressing is applied as before. The treatment is continued in the same way but after 4 or 5 days it will be found that it need only be renewed at 48 hourly intervals. Contrary to what might be expected the dressings are not painful, sepsis does not occur, and healing is extremely rapid. The greatest advantage, however, is the nature of the scar, which is always firm and supple and in the opinion of the writer, superior to the scar resulting from any other form of treatment. The disadvantage is that if a large number of burns has to be treated at one time the method is slow. Nevertheless the cosmetic results are so good that it remains the writer's treatment of choice in burns of the forearm or small burns of the face in women and girls where the cosmetic result is a matter of considerable importance.

**Major Burns:**—It should be accepted as a universal rule that all major burns should be treated in hospital. In serious cases, complicated by shock, management and adequate treatment are impossible, otherwise, and even in less serious cases complications are liable to arise in connection with the long process of healing which may demand expert supervision, and trained and skilful nursing, which are virtually impossible to obtain outside a properly equipped hospital.

Moreover, if a large number of burns has to be treated, it is preferable that a special ward and theatre be set aside in the hospital exclusively for purposes of burn treatment, partly for convenience of organization of surgical and nursing staff, and partly as a means of lessening likelihood of sepsis through cross infection. Sepsis is a most dangerous complication of burns, and steps to prevent it must be taken from the outset. Cross infection from one patient to another must be eliminated, so medical officers and nurses must be surgically clean and wear masks while dressing burn cases in the wards.

The hospital staff dealing with burns should wherever possible work as a self-contained

unit, accustomed to each other's routine, and all thoroughly familiar with the modern principles of the treatment of burns. A nursing staff fully acquainted with the nursing of burn casualties will become accustomed to the significance of changes in the condition of the patient which may not be apparent to the less efficiently trained, and the vigilance of such a staff will without doubt save the lives of many of these unfortunate people who would otherwise die.

In a modern burns ward a really efficient supply of electric power is an absolute necessity, since every bed should have a shock cage fitted with thermostatic control.

As a large proportion of cases will require intravenous fluids, ample provision for their rapid administration must be provided. Regular blood pressure readings, records of pulse, temperature, etc., will have to be taken and charted so that more nurses will be required than would be necessary for a general surgical ward with the same number of beds.

#### Anaesthesia in burn casualties.

It is an axiom that every extensive or severe burn requires complete surgical cleansing, which will very often necessitate a general anaesthetic. A general anaesthetic also enables the surgeon to make a very complete examination of the burn, and allows him to investigate the possibility of other injuries.

It is felt that a full discussion of anaesthesia in burn casualties is not necessary in this thesis, but some of the more important practical aspects will be briefly indicated.

The administration of a general anaesthetic in a severely shocked patient is a matter calling for great skill and judgment and the anaesthetist should if possible examine the patient at the same time as the surgeon and decide in consultation with him what pre-medication, if any, is required, and what method of anaesthesia is best adapted to the needs of the individual case. Atropine gr. 1/150 with or without morphia according to the degree of respiratory depression may be injected intra-venously immediately before beginning the anaesthetic.

The responsibilities of the anaesthetist are greater in the shocked cases seen in casualty surgery than in normal surgical routine. Move-



ment of the patient on the table, for instance, must be restricted to the minimum possible, and ensuring that the patient is kept warm becomes absolutely essential.

Blood pressure and pulse records should be kept if at all possible, and the closest possible watch kept on such symptoms as pallor, sweating, or delayed capillary return.

An intra-venous drip should always be kept ready for immediate use to avoid any possible delay in the event of the onset of sudden collapse.

**Spinal anaesthesia:**—The blood pressure of a patient suffering from shock associated with burns will already be low. Anything tending to lower it still further will increase cerebral anaemia to an extent which may depress the vital centres to a degree incompatible with life.

The early stages of spinal anaesthesia are associated with a fall in blood pressure, although the fall is due to causes quite different from those operating in shock. (23) The shocked patient is not in a position to suffer this additional fall in blood pressure and spinal anaesthesia in such cases is therefore completely contra-indicated.

**Regional nerve block anaesthesia.** In theory this perhaps is almost the ideal method. In order to ensure complete blocking of sensory stimuli, however, very large quantities of analgesic agent are required in cases where the burns are multiple, or extensive in area, and this operates against the general utility of this type of anaesthesia. Its use is therefore restricted to suitable cases, but for such cases, where the surgical team is familiar with the method, regional nerve block anaesthesia must be recognised as of the highest value.

**Intra-venous anaesthesia.** Where an anaesthetist fully conversant with its use is available, this type of anaesthesia has its advantages. By use of an intra-venous drip, barbiturates may be administered over a fairly long period, but in such cases it is almost essential from an anaesthetic machine, or with a B.L.B. to give oxygen throughout the operation either mask. This detracts from the practical value of the method except in cases where short administration of from 5 to 10 minutes are sufficient to complete whatever procedure is necessary. In these cases in particular it should

be remembered that susceptibility to all anaesthetics is greatly increased in cases of shock.

**Inhalation anaesthesia.** Inhalation anaesthesia is suitable for cases of burns except when the burns are accompanied by "blast" injury to the lungs. In these cases avertin anaesthesia, which is not contra-indicated in cases of shock, is most valuable. Deep anaesthesia is not necessary and the amount of anaesthetic used should be as little as possible. Chloroform should be avoided owing to its toxic action on the myocardium, especially in patients with anoxia. Nitrous oxide is excellent but should be used with not less than 20% oxygen. Aether may be used in more severe cases, if possible with an Oxford Vaporiser which facilitates more accurate dosage.

In patients suffering from shock, at least 20% of oxygen should be given in any anaesthetic mixture and this should be increased to 30% or more in the presence or respiratory depression. If respiration is depressed 5% CO<sub>2</sub> may be added.

It should be borne in mind that in pallid subjects anoxia may not be revealed by cyanosis of the skin, although the mucous membranes may be cyanosed.

If a patient has been given a high proportion of oxygen during the operation, this should be continued for some time after leaving the theatre, and the anaesthetist should personally supervise the transfer of the patient back to the ward, and give a report on the patient's condition to the resuscitation team, or other personnel responsible for his further treatment.

## THE TREATMENT OF OLIGAEMIC SHOCK.

Secondary shock accounts for about 80 per cent. of deaths from burns, so that the treatment of burns from the point of view of saving lives largely resolves itself into the treatment of secondary shock.

A patient in a state of severe shock from burns is in urgent need of reassurance, rest, warmth, relief of pain, and fluid to replace the plasma loss. To these may be added oxygen, although this is debatable, and will be more fully discussed later.

As in so many other clinical conditions, it is to a certain extent true to say that the best treatment is prevention. Many actions which are quite easily avoidable may hasten the onset of, or increase shock, and these should never be allowed to occur now that the pathology of shock is more completely understood. Exposure of the patient to cold, rough and careless handling, exposing the entire surface of a large burn at one time to allow unnecessary inspection, cleaning the affected area with spirit or aether, which are cold and irritant, are all procedures which can be avoided with a little forethought. Plasma loss in injured tissues is greatly increased by movement. Complete rest is therefore essential.

Where the nature of the injuries permits, pillows should be removed, and the foot of the bed raised a foot or so, which simple procedure will often raise the blood pressure by 5 to 15 mm. of Hg. In this way the blood supply to the vital centres is assisted, although the measures cannot be used in a patient with head injuries or chest complications.

Reassurance is very important in frightened and anxious patients, as the element of fear is a definite factor in producing and increasing shock.

Warmth can be ensured by the use of hot blankets, electric pads, hot water bottles and warm sweet tea. The latter assists in restoring fluid loss in cases where dehydration is contributing to shock, which occurs more frequently than is generally realised. Blankets used to cover a burn casualty should if possible be sterilized, since the risk of infection of a newly burned area is very great. All casualties who are not unconscious, or suffering from abdominal injury should be given warm drinks freely. If vomiting is troublesome as it often is in burn cases, they should sip the fluid.

The general organization of the reception side of the hospital should be reviewed, and all possible steps taken to ensure that patients are dealt with as expeditiously as possible thus ensuring that they do not get chilled whilst waiting in draughty rooms and corridors. The temperature of all treatment rooms should be kept high; certainly not below 90 degrees Fahr.

Blacklock and Mason (24) have described the dangers of overheating the patient in cases of shock, and state that this may result in the

transfer of as much as half a litre of blood to the skin vessels. Heat should be applied gradually but adequately so as to maintain the temperature of the patient at 98.4 degrees. Heat cages, unless they can be thermostically controlled are a source of danger and as a general rule it is probably preferable to rely on simpler methods readily available.

The relief of pain is of fundamental importance, and calls for morphine to reduce the afferent impulses passing to the central nervous system. Morphine should not be given as a routine measure since in the past, many people who have been given  $\frac{1}{2}$  gr. as a routine soon after injury have subsequently died of increased anoxia and respiratory depression. Its use should be reserved for cases complaining of pain. It should not be given subcutaneously on account of the slow rate of absorption in shocked patients and the risk, if supplementary doses are given, of absorption of large quantities of morphine quickly when the circulation improves. Intra-muscular injection is often sufficient, but probably intravenous injection of one-sixth to one quarter of a grain, injected over a period at least a minute, is preferable. Pain is often not complained of until the circulation is recovering during transfusion, and in such cases the injection may be made direct into the circulation through the rubber tubing of the transfusion set.

The essential feature of the use of morphine is that it should only be given for the relief of pain, and that when necessary to relieve pain it should be given in sufficient doses. Wakeley goes so far as to say that "morphine will never kill a patient who is suffering severe pain." All these measures, although very necessary, are nevertheless of much less importance than the restoration of the lost plasma fluids. In our present state of knowledge this is our sheet anchor in the treatment of shock, whatever may be the cause, and where the state of shock is deep, it is the only measure which will save the life of the patient.

Life can only be maintained by the continuance of an adequate blood volume. The mechanism of circulatory failure which follows on reduction of blood volume has already been described. Only when the volume of circulating blood is adequate can efficient oxygenation of the vital centres take place.

**Pressure dressings:**—There is considerable evidence in favour of the view that loss of

circulatory fluid can be considerably reduced by the application of some form of pressure dressing. This should be applied as early as possible and certainly within a couple of hours of the time of injury. Care must be taken that the dressing is so applied, and constant supervision and inspection must ensure, that the dressing thus applied does not impede the circulation. In cases of burns of the hand or forearm, elevation of the limb well above the level of the heart assists in lessening or preventing oedema.

**Salines:**—It was formerly believed that intravenous saline, or glucose, or gum saline infusions were suitable methods of restoring blood volume to normal. In certain types of injury, for example in severe abdominal injuries where dehydration complicates the condition, intravenous saline may be used in limited quantities to supplement previous transfusion, but this clinical picture is of course never seen in uncomplicated burns.

It is true that intravenous salines do make up the blood volume, but being electrolytes, they pass rapidly into the tissue spaces, and are quickly excreted; so that their effect is very transitory and their practical value negligible (25). Moreover in cases of shock, if sufficient saline is transfused to raise the blood pressure to normal, such a degree of dilution of plasma proteins ensues that the late tissue changes are actually accentuated (26). Glucose contained in glucose saline, not being a colloidal substance, also passes very rapidly from the active circulation, and may lead to pulmonary oedema.

Gum acacia solution, formerly much used, is now almost completely out of favour. It is said to interfere with gaseous exchange and may cause fatal reactions as a consequence of hepatic damage (27). Saline preparations, therefore, have a very limited place in the treatment of shock from burns.

**Transfusion of serum or plasma:**—This is now by far the most important single method of treatment of shock arising from burn injuries. Whole blood transfusion, whilst remaining the ideal method of treatment in injuries accompanied by haemorrhage, is contra-indicated in burns, since it does nothing to reduce the haemo-concentration which has been shown to be a feature of shock in burn casualties as distinct from other forms of injury. Moreover,

pooled plasma has the immense practical advantage that compatibility tests are not necessary, since iso-agglutinins are partially suppressed by pooling, and further inhibited by the patient's blood.

Unlike electrolytes, the protein constituents of plasma neither pass into the tissue spaces, nor are they otherwise excreted, so that by transfusion of plasma the blood volume is both restored and maintained.

There are various methods of preparation of preserved and dried plasma and serum which it is not proposed to describe, although in practice it is desirable to know by which process a given bottle of plasma has been prepared, since filtered plasma may be stored at room temperature, whilst non-filtered plasma should be kept in a refrigerator. Dried plasma has some advantages from the point of view of storage, and is probably less likely to grow organisms.

There is still some disagreement as to the relative merits of serum and plasma. Levinson (28) prefers serum as it is easier to filter and store than plasma, and there is no separation of fibrin. Strumia (29) advocates plasma because of the possibility of reactions following the use of serum, Best and Solandt (30), are of opinion that serum and plasma are generally speaking therapeutically interchangeable. Filtered serum might have some advantage in hypo-proteinaemia since it contains 7 per cent. of dissolved protein as against 4.5 per cent. in citrated plasma (120 cc. citrate, 220 cc. plasma) (31). To avoid repetition, so far as this thesis is concerned, the use of citrated plasma will be described, but serum may of course be substituted.

**Indications for plasma transfusion:**—From what has already been said, it will be clear that restoration of blood volume will only be maintained if sufficient plasma proteins are returned into circulation, thus correcting the disturbed balance of intra-vascular and extra-vascular fluids, and restoring normal osmotic pressure relationships.

It may be taken that as a general rule every patient with a systolic blood pressure of less than 90 mm. Hg. should be given plasma and this should be continued until the systolic blood pressure is at least 110 mm. Hg. The transfusion should then normally be continued by slow drip for another 24 hours at least.

At the same time the blood pressure reading is by no means an infallible guide. If a patient has severe burns, but the blood pressure remains normal, skilled clinical judgement may be required in coming to a decision whether to transfuse or not. If there is any doubt, it is far safer to give plasma than to wait for urgent symptoms to arise. No matter how desperate the condition of a patient may appear to be within 36 hours of injury, transfusion should be started at a rapid rate, as cases are on record where apparently moribund casualties have been resuscitated by massive transfusions of plasma.

**Quantity and rate of transfusion.** As a primary measure, Harkin recommends that in burns deep enough to cause blistering, 50 cc. of plasma should be transfused for every 1 per cent. of the body surface burned i.e. roughly a pint of plasma for every 10 per cent. of the body surface affected.

Many methods have been devised to estimate the quantity of plasma which it is advisable to give in cases of burn shock, but perhaps the most useful are those which depend on the estimation of the degree of haemo-concentration or the volume occupied by the red corpuscles in a centrifuged sample of a standard quantity of blood, which is estimated by means of a haematocrit tube.

Black, (32) in 1940, described a method of estimating plasma deficiency based on the assumption that the haemoglobin is 100 per cent. and the blood volume 5 litres, of which 3 litres are plasma. Since the red cell volume remains unchanged, the increased haemoglobin value observed bears the same relation to the initial value, as the initial value for blood volume bears to the new volume. The formula is:—

$$\frac{\text{Hb}}{100} = \frac{5}{5-x}$$

where Hb is the observed haemoglobin value after the burn and x is the amount of plasma lost. This method is liable to error if the patient has not an original blood haemoglobin value of 100 per cent. so that the final criterion must be based on judgement and experience.

Harkin (33) recommends that 100 cc. of plasma should be transfused for every point the haemastocrit exceeds the normal of 45. If

the plasma proteins are low an additional 25% should be added to the calculated amount for every gramme by which the protein level is below 6 grammes per 100 cc. This method also assumes that the original haematocrit reading of the patient was normal, and the average adult weight is 70 Kgm. The amount of plasma given must be corrected on a weight basis for small adults and for children. The normal plasma protein level is 6.5 to 9 gm. per 100 cc. of blood and any level below 6.5 can be regarded as hypo-proteinaemia. The critical level of plasma protein, that is the level at which oedema begins is given by Moore and Van Slyke (34) as 5.5 gm. per 100 cc. A method for estimating plasma protein is given by Taylor and Gibbons (35).

A useful method of assessing the degree of shock based on an estimation of blood volume has been devised by Bushby, Kekwick and Whitby (36). It depends on the fact that when a known volume of plasma is added to the unknown volume of circulating blood the total of red blood cells remains unchanged. The haemoglobin percentage as expressed by the haematocrit packed cell reading can therefore act as an indicator of the amount of dilution brought about by the transfusion, and provided the observations on the red cells are carried out before, and immediately after, the transfusion of a known volume of plasma, the blood volume of the transfused subject at the time the transfusion is commenced can be determined by a simple calculation. The plasma should be transfused quickly and in this connection Marriott and Kekwick (37) have pointed out that transfusion in cases of severe shock should be at the rate of one pint per 15 minutes or even faster. The method is particularly suitable for shock in cases of burns since the results are generally not in danger of being vitiated by bleeding taking place. The formula for estimating the blood volume is:—

$$V = \frac{P \cdot y}{x - y}$$

where

P = the volume of plasma transfused.

x = the haematocrit reading before transfusion.

y = the haematocrit reading after transfusion.

The normal blood volume in adults is stated to be 40 cc. per pound of body weight and in children and infants about 41 cc. per pound.

The method of Bushby et al. has the great advantage that the patient is not kept waiting for treatment whilst estimates of the correct amount of fluid to transfuse are being made.

Although these recently devised methods of estimating the degree of shock are without doubt based on scientific principles and may in future come into universal use, their practical value is at present by no means universally accepted. Moreover they demand skilled technicians and laboratory equipment which is far from being universally available. It is perhaps true to say that in our present stage of development repeated blood pressure readings and pulse and temperature records are the most practical methods at our disposal. A sphygmomanometer cuff should be left in position and readings frequently taken in all cases of shock under treatment.

The volume of plasma to be transfused should be determined by the response of the patient and the aim should be to restore the blood volume to normal as quickly as possible. In severe cases up to 100 cc. per minute may be given by gravity through a large transfusion needle or cannula until the systolic blood pressure has risen to 110 mm. Hg. when it may be reduced to a drip for 24 hours or more. At this stage the rate of transfusion should not exceed .5 cc. per pound of body weight per hour (38).

In adults with extensive burns as much as 7 to 8 litres of plasma in the first 30 hours have been required to correct haemoconcentration, but the giving of such quantities requires constant watchfulness to prevent pulmonary oedema, although this is not likely to occur provided the infusion rate is slowed after a normal blood pressure level is reached (39).

Apart from the possibility of giving too little plasma in cases of burn shock there is also the very real danger of giving too much and causing the volume of plasma in circulation to rise unduly. This complication is most likely to occur after about 36 hours in severe cases of burns which have been transfused with large quantities of plasma, and is probably due to re-absorption of fluids when the injured capillaries regain their normal permeability.

If the urinary output is low, and especially if transfusion is continued, there is risk of pulmonary oedema which is increased in cases where the air passages themselves have been damaged by the inhalation of smoke or hot gases, or the patient has been subjected to "blast."

**Concentrated plasma:**—Many workers have advocated the giving of plasma concentrated from two to four times, in the treatment of oligæmic shock (40). It would appear to be a rational procedure since if the modern conception of the mechanism of shock is correct, transfusion of concentrated plasma should result in the passage of fluid from the tissues back into the blood stream (41). Muirhead (42) has used plasma concentrated three times which, since it is too viscid to be given by a drip method, he injects with a syringe in doses up to 100 cc. as rapidly as possible, and in quantities up to 900 cc. in a few hours. As compared with massive transfusion of ordinary citrated plasma, concentrated plasma has the advantage that there is no danger of causing pulmonary oedema.

**Technique of plasma transfusion.**—A full description of the technique of plasma transfusion is felt to be outside the scope of this thesis, but one or two practical points will be indicated.

It is far better to tie a cannula in the vein than to use the standard hollow needle, although it is true that is not as important in plasma as in whole blood transfusion. In shock the veins are collapsed and it is often most difficult to gain entry. Even if entry is gained there is always a chance of the needle becoming displaced, with very unfortunate effects.

The cannula is best inserted into the median cephalic or median basilic vein in the arm, the long saphenous vein in the leg, or in the external jugular vein. On very rare occasions no vein may be available and in such cases transfusion of plasma may be made into the bone marrow of the manubrium, or the body of the sternum midway between the angle of Louis and the xiphisternum. The rate of flow by gravity attainable by this route is up to  $3\frac{1}{2}$  c.c. per minute (43).

In all plasma transfusion the strictest aseptic precautions must be maintained

throughout the whole procedure since plasma forms an ideal culture medium for organisms. Any plasma which contains evidence of haemolysis of red cells should not be used if the colour of the plasma is more than the faintest pink. Transfusion of plasma should never be followed immediately by whole blood, as this may result in severe reaction caused by heterologous agglutinins.

**Plasma substitutes:**—Efforts to find some substance which is suitable in every way for use as a substitute for human blood are constantly being made.

Hamilton Bailey (44)<sup>1</sup> says that German chemists have prepared a synthetic colloid which is well tolerated, and is said to maintain the blood volume for two days and become completely excreted in from two to three weeks.

Pure bovine albumen with the same osmotic pressure as human plasma has been prepared and used successfully in human casualties without producing reactions.

Animal experiments have been conducted in Sweden with solutions of pectin suitably buffered with sodium chloride and phosphate.

**Administration of Oxygen:**—Perhaps in no other aspect of the treatment of shock is there so much disagreement as in the value or otherwise of oxygen therapy. Human blood is normally 95 per cent. saturated with oxygen, and its administration to a healthy person will not increase significantly the amount of oxygen in the blood. In the type of anoxia which occurs in shock the oxygen content of the blood is normal but the tissues are not able to take it up in sufficient quantity by reason of the slow blood flow. It is therefore difficult to understand how oxygen therapy can affect this type of anoxia one way or the other.

Clinically it has long been considered that morphia lowers the blood pressure and oxygen restores it. Since many shocked casualties have been given full doses of morphia, they may in theory be given oxygen with benefit, and clinically it has been shown by Melton (45) that efficient oxygen therapy, giving 6 to 8 litres per minute, causes a rise in blood pressure of 20 mm. of Hg. or more, which is not maintained when the administration of oxygen is discontinued.

These findings were not borne out by Frank and Fine, (46) who found that the course of

events in uncomplicated shock was in no way altered by oxygen therapy.

The authors of "The treatment of wound shock" (47) consider it unwise to recommend oxygen therapy in addition to transfusion and are of opinion that it should be relegated to its appropriate place, "when injury to the chest has led to interference with respiratory oxygen uptake, or where there is pulmonary oedema." In such cases of course there can be no doubt of its value, since due to the interference with ventilation the haemoglobin does not become saturated and the arterial blood becomes venous in character.

If oxygen is used it is a *sine qua non* that it must be used continuously and efficiently. It is said that even when 90 per cent. of oxygen is present in the lung alveoli it only increases the amount of oxygen carried by the blood by ten per cent. The complete futility of any method of oxygen administration which does not result in a very high concentration of oxygen in the alveoli is therefore obvious. The B.L.B. mask, by which the alveolar concentration can be accurately controlled is the most efficient, although delivery through nasal tubes with spectacle frame, or by Marriott's (48) method of fitting a football bladder to an anti-gas respirator is also quite satisfactory as an emergency measure. In all methods the oxygen should be passed through water in order to humidify it.

There is undoubtedly scope for further research into the value of oxygen in the treatment of oligæmic shock, and also for improvements in and simplification of the methods of administration.

On the whole, however, clinical experience suggests that it is of value when properly administered, and in the odd case may be the determining factor in saving a patient's life.

**Pressor substances:**—Great hopes were formerly raised that desoxycorticosterone acetate would prove a great life saving agent in treatment of shock. Its action is not completely understood. It is known that in shock there is disturbance of the normal balance of sodium and potassium ions in the blood serum, the potassium being increased and the sodium decreased the sodium being presumably lost into the injured tissues. Natural supra-renal hormone, cortin, and the synthetic product,

desoxycorticosterone acetate, appear to mobilize sodium from an unknown source and enable the blood serum to retain this sodium in circulation (49).

In practice their use is said to prevent the onset of post operative shock if given in the pre-operative period and continued for two days afterwards, but in cases of established shock reports are very conflicting, and their value is at present far from being established.

**Cardiac stimulants:**—Cardiac stimulants raise the blood pressure and increase the force of the heart beat for a short time but since shock is not a condition primarily affecting the heart or the cardiac centre there is no very definite indication for the use of cardiac stimulants.

**Opinions** differ, but on the whole it is probably safer not to use them, as the patient may die during the period of reaction following stimulation.

**Injection of potassium salts into the cisterna magna:**—Experimental work has been carried on in Moscow by Stern (50) by injecting potassium salts into the cisterna magna in order to stimulate the vegetative nervous system by alteration of the calcium/potassium balance. Excellent results are said to have been achieved by Russian surgeons in cases of shock, by cisternal injection of 1 c.c. of a solution of potassium phosphate in a concentration of 1/6 gm. molecule with a PH of 7.6. Further details of clinical trials are necessary before the value of this method of treatment can be completely assessed.

## THE TREATMENT OF THE BURNED AREA.

Many methods of local treatment of major burns have been adopted, but in general they can be described in two main divisions:—

- (i) Those whose action depends on the principle of tanning.
- (ii) Those whose action does not depend on the tanning principle.

**Preliminary treatment:**—Before any method of treating the burned area is applied, all possible measures to prevent or treat shock must be commenced. A thorough surgical cleansing of the whole area is then undertaken, and in most instances this will necessitate a general anaesthetic. The necessity for strict

asepsis must be borne in mind, and caps, masks, gowns and gloves should be worn just as for a major operation.

No antiseptics, aether, spirit, or aether soap should be used, but loose and blistered skin should be cut away, the edges of the burned area carefully excised, and the whole area carefully cleansed, removing gross contamination and dead skin with warm isotonic saline. Where possible any reddened epidemic round the burn should be removed to lessen the likelihood of subsequent blistering. A saline pack is then applied and left in situ for 5 minutes.

(i) **Tanning methods:**—The principle of tanning in the treatment of burns was first introduced by Davidson (51) in 1925, and had as one of its main objects the precipitation of the proteins of the damaged cells, reduction of autolytic changes, and consequently lessened toxin formation and absorption. In practice it was found that tanning also relieved pain, reduced the incidence of bacterial infection, and prevented loss of fluid from the surface of the burned area.

A later development was an attempt to overcome the disadvantages of infection under the tan, tannic acid not being bactericidal. With this object in view Bettaman (52) in 1937 introduced a method using 10 per cent. silver nitrate in addition to 5 per cent. tannic acid and many modifications of the same principle were introduced later, notably by Fantüs and Dyniewicz (53) who employed a solution containing salicylic acid as an additional bactericidal agent.

There can be no doubt that the introduction of tannic acid for the treatment of burns was a great advance, and that it resulted in greatly reduced mortality from burn injuries (54). Later work, however, shows that the good results were not entirely the outcome of the main reasons for which the treatment was originally introduced by Davidson, namely the fixation of toxins, but from what were originally regarded as subsidiary factors.

The deterioration which sometimes sets in about 30 hours after injury in patients who appeared to be making good progress and which has been regarded by many as a form of toxæmia arising from destruction of tissue has already been described. In cases where

there is obviously sepsis the syndrome is not difficult to comprehend, but in others, where infection can be excluded with reasonable certainty, the mechanism is difficult to envisage. At the same time the evidence for attribution of the symptoms to some form of toxæmia was supported by the undeniable fact that the post-mortem findings in such cases often showed severe liver necrosis.

In 1938 Wilson et al. (55) pointed out that toxæmia was more common and severe in burns treated with tannic acid than in burns treated by other methods.

More recent work still, has shown that severe centra-lobular necrosis of the liver after burns probably only occurs which tannic acid treatment and results from the absorption of tannates.

Robinson and Graessle (56) say that risks of tannic acid intoxication may arise when there is a large raw surface, or possibly exposed blood vessels, where tanning is used in treatment. They suggest therefore that tannic acid preparations should not be used for burns of this type, although they agree that possibly it still has some place in the treatment of body burns.

Tannic acid as a tanning agent has as a result of this recent work fallen into disfavour during the last two or three years and has been replaced by other tanning preparations which have not its serious drawbacks.

**Aniline dye preparations:**—Aldrich (57) in 1937 advocated the use of a compound of aniline drugs, claiming that infection is the greatest factor in the production of toxæmia, and that the anti-septic action of a combination of acriviolet and brilliant green is advantageous. Other aniline preparations have since been used with good effect and are probably the best method of tanning at present available.

Some surgeons use an aqueous solution of one to two per cent. gentian violet, but a more general favourite is an aqueous solution of triple dye (Gentian violet 1 in 400, brilliant green 1 in 400, flavine 1 in 1,000). Whichever solution is used should be swabbed on or sprayed from a suitable spray and the whole then completely dried by hot air from an hair drier. The air entering the drier filtered through wool and the person

operating it should wear a mask. This results very quickly in the formation of a thin supple tan over the burn. No dressing is applied, and the patient is kept in bed under a shock cradle. If properly applied the tan should remain firm and in good condition for about a fortnight. After the original application the chief requirement in treatment is to maintain a careful watch for the onset of sepsis. This is most likely to occur at the edges of the tanned area especially if fresh blisters appear. The tan should be carefully examined at 12 hourly intervals and if there is any appearance of exudate at the edges this must be treated very promptly by applying the tanning solution. Cracks in the original tan may also appear and if they do, they also must be treated with the tanning agent.

Difficulties in nursing are bound to occur in many cases, particularly when both aspects of the trunk are involved. In such cases the patient should lie on the less affected aspect on a sterile towel which has been wrung out of sterile liquid paraffin, which has the effect of lessening friction.

In some cases sepsis may become well established under the tan and in these there is no alternative to removing the whole tan under a general anaesthetic. The whole area may then be treated with saline packs kept constantly moist, or by some other non-tanning method of treatment.

In such cases the introduction of the sulphonamide group of drugs has greatly reduced the danger of severe sepsis. Oral sulphonamide, however, is not necessary as a routine measure and should only be given when sepsis is obviously developing.

If it is indicated the dosage should be adequate, since if an effective dose is brought to bear on haemolytic streptococci and staphylococci during the early phase of rapid increase of the organisms, acute infection will usually be aborted before serious damage has resulted.

The first dose should be from 2 to 4 grammes followed by 1½ gramme doses four hourly for two days. The dose should then be reduced to one gramme four hourly for another two days after which it should be reduced to one gramme every six hours as the clinical condition improves. In treatment of burns chemotherapy should not be prolonged, but may be



continued for seven days, after which treatment should cease, a second course being given, if required after an interval of one week.

The usual precautions should be adopted, and leucocyte counts carried out to give warning of the possible development of agranulocytosis. In patients treated with sulphapyridine or sulphathiazole the giving of sufficient fluid to ensure a large urinary output so as to minimise the risk of blockage of the urinary passages is most important.

**Other tanning agents. Mercurochrome:—**This was recommended by Turner (58) in 1935 for use as a 2 per cent. aqueous solution. Its main advantage is that it forms a transparent coagulum which enables progress or otherwise to be easily assessed. Later work by Ogilvie, (59) however, showed that it was very deficient in bactericidal power. It has therefore fallen into disrepute.

**Amyl acetate:—**Stewart (60) in 1937 recommended the use of a preparation of amyl acetate for treatment of less severe and extensive burns. Amylacetate is slightly analgesic but has little if any bactericidal action. It was therefore combined with abraclide, an anti-septic. It was applied on swabs direct to the burned area the swabs being moistened with fresh solution every four days. Its great disadvantage is its penetrating odour and this has prevented its wider adoption.

The aim in local treatment of first degree burns is to maintain a dry impermeable tan until epithelialization is complete or nearly so. In second degree burns the object is to prevent bacterial invasion and obtain a healthy granulating surface as early as possible to permit of early skin grafting.

These objects are usually attainable but in certain burns where deeper structures have been involved there is often already a coagulum of charred tissue and local thrombosis of blood and lymph vessels. There is therefore little loss of fluid from the burned surface, but a great tendency to oedema. The type of coagulum present in this type of case will not prevent sepsis no matter how careful the original surgical toilet of the wound.

Tanning methods are therefore of little use, and this type of burn must be treated by some non-tanning method (61).

## (ii) Methods of treatment not depending on tanning.

**Saline baths:—**The treatment of burned patients in baths containing fluids is one of the oldest therapeutic measures known to medicine, and from about 1930 onwards has been resuscitated as a means of treatment by many surgeons, the rationale as against coagulation methods being that a coagulum is liable to inhibit the process of sloughing and therefore hinder natural repair. Plain water, physiological saline, mild anti-septics and hypertonic salt solution have all been used (62).

Following the strong criticism advanced against tannic acid treatment, non-tanning methods received an additional fillip and treatment by saline baths has recently become very widely used for war casualties, notably in the R.A.F.

The treatment, in brief, consists of immersion of the patient in a saline bath which is kept at a constant temperature. The bath must be sterilizable, and a constant stream of sterile saline, maintained at correct concentration, and at a temperature of 100 degrees Fahr. is run in. The sterility of the saline used is ensured by bi-weekly bacteriological examinations, and the bath itself should be sterilized after use by scrubbing with soap and mopping with pure lysol, after which it should be swilled with the sterile saline.

Treatment by saline bath should not be commenced until shock is under control, and until this stage is reached the burn should be treated by dusting with sulphanilamide powder and applying tulle gras dressings.

When the bath treatment is commenced outer dressings should be removed, leaving the tulle gras dressing in situ, and the patient lifted bodily into the bath by specially trained nurses or orderlies. Care must be taken to cause the patient as little pain as possible and all nursing personnel should maintain complete aseptic technique. The patient should be encouraged to move his limbs as freely as possible whilst in the bath, which will help in washing off the dressings. Even adherent dressings come off in due course in this way and the lack of pain is a very important factor in maintaining the patients well-being.

As soon as the dressings have become detached the burned surface should be cleaned

very gently and carefully with swabs of cotton wool. In this way all secretion can be removed, and dead tissue and epithelial and sebaceous debris from the edges of the burn detached. The average time for all this to be done, and during which the patient will remain in the bath, is up to three-quarters of an hour.

Whilst the patient is in the bath the sheets on his bed should be replaced with sterile ones, and after bathing he should be returned to bed and the unburned portion of his body quickly and carefully dried with warm towels. The burned area should be insufflated with sulpho-hamide powder before it becomes quite dry and then covered with a single layer of tulle gras. Over this are placed light packs of saline soaked gauze. It is very important that the patient should not be allowed to become chilled during this procedure, and this may be prevented by the use of a suitable electric radiator.

The baths are best given in the morning, and during the day the dressings should be kept moist with saline to prevent them from sticking. In order to be quite certain that the dressings never become dry it is wise to remove them twice in 24 hours, leaving the tulle gras in position, and replace them with fresh dressings.

The burn, if this procedure is accurately followed, is never fully exposed except in the bath. Baths should be repeated daily although in very septic cases it may be advisable to give them twice daily.

It is said that under this regime, sepsis is quickly brought under control, (63) and that the time taken to heal first degree and less serious second degree burns is less than half that taken by any other method whilst in second degree burns involving deeper structures many months may be saved in treatment.

One great advantage is that very early movement of the part is permitted, and there is therefore no danger of prolonged immobilization leading to impairment of function.

There are certain contra-indications. The successful employment of this method necessitates a patient who is co-operative. With young children as a result of fear, it may be impossible to persuade them to remain in the

bath, and forcible methods are, of course, in the circumstances impossible.

The method is not suitable for cases with badly exposed tendons and open joints.

If associated injuries such as fractures are present, placing of the patient in the bath may not be possible.

Although certain surgeons object to the method on the ground that control of infection is lacking, and that there is no control of fluid loss, there seems to be little doubt that in practice it is most satisfactory once the dangerous period of shock has been safely weathered.

Probably the most serious practical objection is that a good deal of rather expensive apparatus is necessary if the method is to be carried out efficiently for a large number of cases. This is a serious drawback in war time in operational areas and in cities liable to air attack, but in surgery in peace time is not so important. There is therefore probably a great field for this therapeutic measure in industrial traumatic surgery after hostilities have ceased.

**The Buryan-Stannard bag (64):**—In this method of treatment the whole of the area is enclosed in a silk envelope, which is sealed off in such a way that cross infection is impossible. The envelopes are made of fine pure silk cloth coated with synthetic resins which are not affected by hypo-chlorites or by boiling. Suitable shapes have been designed to fit any part of the body.

Different concentrations of a stock solution of one per cent. electrolytic sodium hypochlorite containing 16.5 per cent. by weight are employed as an irrigating medium, according to the situation and severity of the lesion.

Surgical removal of burned tissue is first carried out as in other methods of treatment, after which the solution is kept flowing over the lesion and surrounding parts until the envelope is applied. The burn is then irrigated with the solution three times a day for periods of twenty minutes until healing is well advanced, the envelope being left undisturbed in the meantime. The envelope is transparent so that the progress of healing can be observed throughout.

The process sounds rather complicated, but in practice is not so, since changing of the

envelopes is not necessary, and the technique of irrigation is simple.

It is claimed that in this method of treatment fluid loss is stopped almost immediately and in most cases pain is quickly relieved. Movement of the affected part can be started very early and this is of special value in cases of burns of the hands. Toxaemia is unusual as the products of tissue break-down are carried away as soon as they form. In burns covering a large area, a healthy base for skin grafting is quickly available.

**Sulphonamides and penicillin:**—The discovery and introduction of the sulphonamide group of drugs, and later of penicillin, has resulted in a great advance in the treatment of burns, with consequent reduction in mortality, although full appreciation of the place of penicillin in such treatment is not yet possible, as the drug has not yet been manufactured in sufficient quantities to permit of general release, and trial on an extensive scale. The internal administration of sulphonamides as part of the treatment of infected burns has already been described, and its use in certain circumstances as a local application has also been indicated, although its employment as a sole method of treatment remains to be dealt with.

As a local application it is probable that the greatest value of these drugs is in cases where sepsis threatens to supervene, but many workers have used preparations of sulphonamides from the beginning of treatment, basing their rationale on the well-known fact that burns are probably more prone to infection with haemolytic streptococci than almost any other form of injury.

A method of treatment of burns employing micro-crystalline sulphathiazole has been employed with apparent success. In this method the burn is cleaned in the usual way after which it is insufflated with powdered micro-crystalline sulphathiazole until the area is thinly dusted with the powder. The whole is then covered with sterile gauze and tightly bandaged to prevent oedema and loss of plasma into the surrounding tissues. The burn is dressed in this way every third day.

Burns involving total skin loss are skin grafted as soon as a healthy granulating surface is formed, and it is said that the application

of the sulphathiazole does not interfere with the viability of the grafts.

Wallace (65) has used a paste consisting of 30 per cent. albucid soluble (which is a soluble sulphonamide) and 10 per cent. of cod liver oil with equal parts of kaolin, and has found it to be particularly efficacious in burns of the face.

In some cases, especially in burns of the hand, sulphonamide powder has been used as a dressing, covered with tulle gras, and the whole encased in a light plaster cast. The plaster is applied so that the wrist is immobilized, but the fingers are free inside the cast. The patient must be instructed to move his fingers frequently.

Evans and Hoover (66) have treated burns with a cream of sterile sulphonamide powder mixed with lanolin and cold water so that the final concentration of sulphonamide is 6 per cent. by weight. There was an occasional sulphonamide rash, but no other systemic reaction attributable to the drug.

Colebrook and other workers (67) at the Glasgow Royal Infirmary have obtained good results as a first aid measure from a cream containing 10 per cent. sulphonamide and 1 per cent. cetyltrimethylammonium bromide, which is designed both to prevent multiplication of bacteria on the burned surface, and also to be easily removable if other treatment should be found necessary.

In cases necessitating more complete treatment the same workers have used a water soluble cream containing sulphanilamide and glycerine prepared according to the following formula.

Sulphanilamide	... 10 gm.
Glycerine	... 10 gm.
Oil Ricini	... 25 gm.
Janette wax SX	... 10 gm.
Water	... 45 gm.

All blisters are first cut away, and a surgical toilet carried out in the usual manner. The burned area is then cleansed with cetyl-trimethyl-ammonium bromide solution. The cream is then applied direct with a spatula, or on gauze or other suitable form of dressing, covered with wool, and firmly bandaged.

The dressing is left undisturbed for from 6 to 10 days after which it is removed and a

similar fresh dressing applied if found to be necessary.

It has been found that absorption of sulphanilamide is usually not great. In most patients a blood concentration of from 1 to 6 mgm. per 100 c.c. is reached during the first three or four days.

In some cases of very deep or extensive burns higher concentrations were reached and in such cases it is suggested that the strength of the cream be reduced to 3 per cent., or that the sulphanilamide should be replaced by sulphathiazole which is less soluble and therefore more slowly absorbed.

Insufflation with a Stanford Cade's sulphonamide insufflator is probably the best method of application of sulphonamide powder but one difficulty is that the powder is hygroscopic and therefore tends to clog. Some workers have found it simpler and more satisfactory on the whole to apply the powder from a sterile swab.

Certain precautions are necessary in its use, of which perhaps the most important is that it should be sterilized before application.

Attention was first drawn to the necessity for this in 1942 when a fatal case of tetanus was reported (68) and it was concluded after investigation that the infection with tetanus spores could only have occurred through contamination of the sulphanilamide used. The possibility was confirmed experimentally by Welch et al (69) who showed that if sulphanilamide powder containing tetanus spores is implanted into the tissues of animals, the presence of the drug does not prevent the onset of tetanus.

Sulphanilamide should therefore be sterilized before use by one of the methods recommended by the Medical Research Council (70), and the resulting product discarded if it becomes discoloured.

The danger of absorption of toxic quantities of sulphonamides should also be kept in constant mind even in local treatment. Blood concentrations exceeding 50 mgm. per 100 cc. have been recorded after insufflation of extensive burns with sulphonamide powder on three successive days. Estimates of the sulphonamide content of the blood should be carried out by Fuller's method (71), which only requir-

ed a few drops of blood, and is sufficiently accurate for clinical purposes. Blood concentration should never be allowed to exceed 10 mgm. per 100 cc. in the case of sulphanilamide or sulphapyridine and 7 mgm. per 100 cc. in the case of sulphathiazole.

Sulphathiazole is the drug of choice for local application as it is absorbed very much more slowly than the other members of the sulphonamide group. (72).

**Penicillin:**—Penicillin probably marks the greatest single advance in the treatment of septic conditions since the original discovery of the principle of antiseptics. Difficulties in its supply have hitherto prevented its trial on an extended scale except in military formations. Literature describing its use in cases in which it has been employed by the military authorities has as yet been published in comparatively few cases. Enough has been revealed, however, to show that the vistas opened up by its use are well nigh limitless.

The accidental inoculation of a culture plate with the mould of penicillium notatum some years ago caused inhibition of the growth of staphylococci near it, and this was noticed by Alexander Fleming. (73) Fluid cultures of this mould showed that it contained a substance, penicillin, which inhibited the growth of many gram positive bacteria.

More recently Florey and others (74) have purified penicillin and showed that it will inhibit the growth of staphylococcus aureus and streptococcus pyogenes in a dilution of 1 in 1 million even in the presence of pus. It is therefore many times more powerful than the most potent of the sulphonamide compounds. It has been used intravenously without toxic effects and is excreted in the urine from which it can be extracted.

A practical method of application of penicillin has been described by Clark et al (75). Penicillin was made into a soft yellow cream by adding it to a molten mixture of lanette wax SX and castor oil, and used in the treatment of a series of 42 cases of burns.

It was found that this cream retained its activity for 15 days at ordinary room temperature in the United Kingdom, and for over 4 weeks at a temperature of 2 degrees Cent.

The minimum application for elimination of haemolytic streptococci appeared to be about four applications of the cream, containing about 100 to 150 Oxford Units per gramme. Staphylococcus infection was also improved, but appeared to require a higher concentration of penicillin. Coliform bacilli, *B. Proteus*, and *Pyocyaneus* did not usually disappear.

Further work with penicillin is undoubtedly being carried on on an extensive scale and the results will be awaited with eagerness throughout the civilized world.

### BURNS OF SPECIAL AREAS.

**Burns of the hands and fingers:**—The general principles which have already been enunciated apply with equal force to burns of the hands, but in addition there are some special features of these burns which call for special comment. Firstly it is most important that the problem of preservation of function be kept constantly in mind, and it should also be remembered that the problem is made more difficult by reason of the fact that the hand probably harbours more organisms than any other part of the body. These two factors are largely inter-dependent since sepsis is the cause of severe scarring which in its turn is likely to interfere with the very complicated mechanism of full function of the hand and fingers. It is therefore vital that any early form of dressing used should be antiseptic in nature, and in practice it has been found that gentian violet, or triple dye jelly, are most suitable since they have the additional advantage that the thin supple tan they produce has no tendency to contract.

Up to comparatively recently tannic acid was almost the universal form of treatment for burns of the hand, but in addition to the general drawbacks to its use which have already been described, the coagulum is apt to contract and interfere with the vascular supply to the fingers, giving rise to disastrous results which may even go so far as to cause ischaemia and necrosis of the terminal phalanges.

There are certain other points which should be kept in mind. Blisters should be opened with strict aseptic precautions, but the epithelium left in situ. The coagulating medium applied should be applied only to the burned area and the margins of the burns covered by a very narrow strip of coagulum. If large

areas of unaffected skin are covered slight contraction of the healthy skin is caused and is apt, in combination with the tan on the burned area, to cause interference with the blood supply, a complication which must be avoided at all costs. The earliest sign of interference with the blood flow in the digital arteries is pain in the finger tips and this should always be enquired about in cases of burns of the hands and fingers. If this symptom occurs the tan should be split and the arm kept well elevated.

The treatment of burns by the envelope method and by the application of sulphonamide and plaster has already been described. In the former method there is little danger of deformity being caused by fixation of the hand in bad position, but in tanning methods and in the plaster method this is a danger which is ever present.

Care should therefore always be taken to ensure that the fingers are well separated between pads, and the hand placed in the position of function, with the wrist at 60 degrees of dorsiflexion, all the finger joints at 50 degrees of flexion, the thumb being separated from the palm in abduction and opposition, and the second phalanx of the thumb in slight flexion.

In deep burns of the hands, as soon as any dead tissue has sloughed and healthy granulations are present, skin grafting should be carried out without delay.

Loss of skin itself may lead to severe distortion, and in these cases any skin contraction should be released early, when in the case of younger people intra-articular changes may be prevented, although in older persons the outlook is not nearly so good.

**Burns of the face:**—Burns of the face also present certain special problems. The necessity of adopting methods of treatment which will obviate unsightly scarring are obvious. Apart from this the face is very vascular, and this is liable to lead to excessive fluid loss in the early stages, and a degree of toxæmia disproportionate to the size of the burn in later stages.

The line of treatment depends to a certain extent on what facilities are available for treatment during the first day or two after injury. Where these are limited it is probable that the application of gentian violet or triple

dye jelly is on the whole most likely to prove satisfactory. If hospital treatment is possible within a few hours, saline masks are probably the best form of treatment. The burned area should be carefully cleansed under a general anaesthetic, after which a gamgee mask is made to fit the face, with openings for the nose and mouth. The burned area is dusted with sulphonamide powder and covered with tulle gras after which the mask is applied and kept continually moist with a saline drip.

Tannic acid should never be used in casualties suffering from burns of the face.

In burns involving total skin loss early skin grafting is essential if scarring is to be prevented, and this should be done as soon as a healthy granulating surface is present.

In many cases of burns of the face the eyes will be affected, and in all cases of burns of the face attention must be paid to the eyes, even if they have not obviously been involved. They should be bathed if necessary with boric n and instilled with argyrol. If the to stick they should be smeared with ngt. Hyd. Ox. Flav. or cod liver oil.

In the early stages, when the eye has been affected the cornea may appear perfectly clear and at this stage it is most difficult accurately to estimate the actual extent of the injury. In severe cases the cornea quickly becomes dull and opaque and an eschar may form. This is followed by granulation and frequently ulceration of the cornea. Adhesion of the lid to the surface of the eye is a real danger and every precaution must be adopted to prevent this occurring.

#### Skin grafting of burn injuries.

One of the main objects in the treatment of burns is to obtain sound healing with the least possible delay and to avoid unsightly and disabling contractures if at

devoid of hair, and with no sebaceous glands. The surface breaks down very easily following the slightest trauma, or even with variation in tension following normal movement.

The reason for this is that underneath the newly formed epithelium is fibrous tissue very deficient in vascularity, instead of true derma which would support and attach it to the subcutaneous tissues.

To prevent this unsatisfactory epithelialization the logical procedure is to cover raw areas with whole skin as soon as possible. This of course necessitates the presence of a healthy granulating surface with a spontaneous healing tendency. The methods of attaining this have already been described.

The surface should be smooth, pink in colour, level with the surrounding surface or even slightly depressed, and painless to touch. The edges should show epithelial response in the shape of a bluish white margin of epithelium attaching itself firmly to the granulations. An infected surface, with painful, soft, greyish granulations, perhaps exuding a little pus, is not in a suitable stage for skin grafting. If the surface is in this stage it must be conditioned before grafts can be applied and this is best done by application of saline dressings every two or three hours, alternating with eusol packs. Firm pressure is useful in keeping down granulations, and may be maintained by the application of crepe bandages. The dressings may be kept moist by covering them with jaconet or oiled silk. As the condition of the surface improves, the eusol may be discontinued and saline packs alone applied. Under this regime rapid improvement is usual and an indication that the infection has been controlled is the disappearance of pain and absence of the surface to the touch. If necessary the use of sulphonamide or penicillin is necessary to bring sepsis under control.

they result in a spotty appearance. Their greatest use is in hastening healing in areas which are difficult to condition properly, as they frequently 'take' when other methods of grafting fail. The method consists in principle of removing small pinches of skin under local anaesthesia and applying them direct to the clean granulations. The method is obviously rather slow, and has the added disadvantage that slow epithelialization favours the development of scar tissue. Pinch grafts, therefore, although they have their place in the treatment of burns, especially for extensive skin loss on the trunk, or legs, where large razor grafts from other sites cannot be obtained without difficulty, are by no means the method of choice.

The technique consists of removing small cones containing all the layers of the skin by lifting a small pinch of skin with a straight needle, and severing its base with a sharp scalpel. The cone of skin thus removed is applied directly to the granulations, which have been previously prepared with saline, but not scraped, so that its epithelial edges are spread flat on the surface. Further grafts are then applied in rows one cm. apart. The whole is then covered with tulle gras and afterwards with two layers of gauze wrung out of paraffin and flavine. Pressure is applied by means of a bandage tightly applied. The dressing is ordinarily left undisturbed for about a week. If any sepsis is apparent saline dressings should then be continued, but if not, tulle gras dressings should be applied.

**Razor grafts:**—Razor grafts consisting of epidermis, dermis, and small amounts of corium are probably most useful of all, since they are applicable for delayed covering or granulating surfaces, or for the relief of late contractures. Areas up to 180 square inches or more have been successfully covered at one time by grafts of this type.

The technique of razor grafting is a highly specialized art only to be learned by practice and experience. No attempt will, therefore, be made to describe the procedure in any great detail, but the general principles involved will be briefly indicated.

Most surgeons of experience take their grafts by means of a razor sharp knife with a "biting" edge, the only other equipment re-

quired being a board or Blair sucker to flatten the skin in front of the knife. The graft should be taken with sawing action as thickly as possible without involving the subcutaneous fat. Grafts can be taken from the inner or outer side of the leg, or from the inner surface of the arm. The thickness of the graft being taken can be estimated by the colour of the cutting edge of the knife as seen through the skin. When the graft is getting too thin the edge can be plainly seen and appears bluish grey in colour. At the best thickness the colour is yellowish white. If the graft is too thick it appears opaque and the edge of the knife cannot be seen. At this stage it is probable that subcutaneous tissue is being included in the graft.

Less experienced surgeons may use a Humby knife, which has adjustable guard which prevents the taking of too thick a graft.

A more elaborate instrument is the Padgett dermatome.

The graft having been taken it must be applied to the raw surface under treatment.

The granulating surface having been washed with normal saline, and the surrounding skin prepared with aether and spirit, the granulations should be scraped away until the deep fibrous layer is reached, or excised down to healthy tissue. Bleeding must be controlled by pressure, hot packs, or applications of 1 in 1,000 adrenalin.

The grafts should then be laid with the raw surface outwards on tulle gras dressings, after which the tulle gras should be applied to the raw surface and fixed with a few sutures round the edges.

The dressings should be removed at the end of a week. If the graft has been successful it should be covered with a saline dressing for a few hours and then protected with a tulle gras dressing for a few days.

If the graft has not been successful, the wound will at some stage discharge and emit a foul odour. If this occurs the whole dressing must be removed and saline and eusol packs applied.

If there are small areas still uncovered in an otherwise successful graft, saline and eusol packs may be applied, or gentian violet or triple dye painted on to the raw areas.

Finally it may be stressed that to allow an extensive raw surface to heal by natural processes and formation of scar tissue is a procedure which in these days can in no way be justified.

### NUTRITION IN BURN CASUALTIES.

Burn casualties are liable to develop certain metabolic conditions which demand some consideration from the point of view of diet and general management, and attention to these details is likely to promote early convalescence and improved end results.

In infected cases with fever, for example, there is increase in body metabolism. In addition there is likely to be a heavy loss of protein in exudates. Secondary anaemia is a frequent complication of burns as of other debilitating conditions, and must be treated if occasion arises.

Wallace (76) has shown that where a granulating area is in existence for a long period there is a heavy loss of body chloride. Besides these the possibility of acidosis and liver damage must be borne in mind. It is estimated that two-thirds of the body's sulphur is contained in the skin, and in cases where there has been extensive skin loss the replacement of the lost sulphur becomes a matter of some consequence.

With the increase in the metabolic rate increase of all three food principles is necessary. Taylor (77) has shown that in severely burned patients the excretion of nitrogen is excessive and there is a large increase of residual nitrogen in the urine. It is therefore fundamental to advocate a high protein diet in all severe cases of burns in order to replace this excessive loss of nitrogen.

Both the nitrogen loss and the sulphur loss can be well treated by a diet with plenty of eggs, the theory that such a diet precludes the use of sulphonamide drugs being now exploded.

In suitable cases a high salt diet will prove a stimulant to healing in patients with a large granulating area from which there has been continual loss of chloride.

Iron in the form of ferrous salts, or scale preparations may be used if anaemia is among the symptoms.

Dehydration is a very real problem in burn cases, and must be guarded against, particularly in hot climates where fluid loss through

the skin is likely to be great. The disturbance of renal function following burns has already been described, but within 48 hours after the receipt of injury renal function is as a rule restored, and fluid intake in adults should be at least 5 pints in 24 hours. The volume of urine in adults should be maintained at at least 1,000 c.c. daily. If 1,000 c.c. to 1,500 c.c. are allowed for vaporisation from the skin and lungs, and 200 c.c. for water contained in the stools, the total fluid loss is 2,200 c.c. to 2,700 c.c. and this must be adequately replaced if the patient is to make satisfactory progress.

In the early stages the administration of glucose is beneficial especially if there is a tendency to acidosis and possible hepatic damage, since, following absorption, glucose helps to protect the liver cells from circulating toxins.

Up to 10 ounces of glucose may be given in 24 hours and it is often helpful to give it together with orange or lemon or lime juice, since this also increases the vitamin intake.

### CONCLUSION.

The primary object in treatment of injuries caused by burns, as in treatment of all other forms of injury, is to save life.

The biggest single factor in the causation of deaths from burns is oligæmic shock. The advances which have been made of recent years in the treatment of this condition have been so great, that even extreme cases are capable of resuscitation, provided the necessary highly trained personnel and other treatment facilities are available. At present this includes ample supplies of blood plasma which can only be obtained if healthy individuals are prepared to donate their own blood for the relief of the sick and injured.

It may be that at some future date an effective substitute for human blood plasma will be perfected, or shock will be amenable to treatment by some other means, but that date is not yet, and in the meantime the organization of an efficient blood bank in every large centre of population is an essential feature of the treatment facilities for all forms of traumatic surgery. Given ample supplies of plasma, and the equipment and staff for its proper administration, the problem of treatment of oligæmic shock can be reduced to relatively small proportions.



Further important objects in the treatment of burns are to reduce to a minimum the period of incapacity, and to maintain function by the prevention of deformities. The introduction of the "tanning" method of treating burns; the use of saline baths, and envelope treatment; the discovery of the value of the sulpho-  
namide group of drugs and pencillin in preventing sepsis; and the immense strides which have been made of recent years in the technique of skin grafting, have all contributed in very large measure to the attainment of these objects.

Whatever may be the horrors of war, there can be no doubt that during wars at least one good result emerges, namely advancement of medical and surgical knowledge.

Scientific medical effort has up to now been too much occupied with the practical problems of the emergency to devote much time to statistics and analytical records, but when these are finally available, there can be little doubt that they will reveal that the advances in medical and surgical science which have been made, have been greater by far than corresponding advances made at any comparable period during human history.

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## APPENDIX

## CASE RECORDS

The following extracts are taken from case records of 270 burn casualties treated by the author following air raids on two large industrial cities in the North of England in December, 1940.

The extracts have been chosen as representative illustrations of some of the methods of treatment which have been described in the preceding pages.

Most of the cases were originally received in a combined hospital and first-aid post operating in the middle of a heavily bombed target area.

Of the 270 burn cases seen, 57 were discharged to the care of their own doctors immediately after receiving first aid treatment. 128 were detained for periods up to 48 hours, after which they were treated as out-patients or discharged to the care of their own doctors.

More serious cases were, whenever their condition allowed, transferred to a base hospital outside the target area within a period of 48 hours. 53 such cases were so transferred, the remaining 32 being either dead, or too ill to stand removal.

The total mortality was 19, which included 7 cases who were moribund on admission. The remaining 12 cases were all comparable to cases Nos. 39 and 95 quoted below having suffered very severe burns, in several instances complicated with other serious injuries.

**Case No. 4:—**Hannah F..... aged 37 years, rubber worker. Second degree burns of palmar surfaces of both hands and forearms following attempts to extinguish a thermite bomb with

a bucket of water. First seen half an hour after receipt of the injury. General condition good, blood pressure 85/130 mm.  $\frac{1}{4}$  morphia injected intra-muscularly, and one pint of warm sweet tea by the mouth. Two hours later general condition remained good. Surgical toilet under gas and oxygen anaesthesia and burned area treated with triple dye. Transferred to base hospital after 24 hours. Finally discharged on 24th day. Burns healed with full function. General condition good.

Case No. 17:—James R. . . . aged 42, A.R.P. rescue worker. Severe burns of the palmar surfaces of both hands due to grasping a burning rafter whilst releasing a trapped casualty. First seen one hour after receipt of injury. General condition good. Given gr.  $\frac{1}{2}$  morphia intra-muscularly and one pint of hot sweet tea. After 2 hours general condition still good. Pulse 90. Systolic Blood Pressure 135 mm. Injury cleaned up under gas and oxygen anaesthesia and dusted with sulphanilamide powder. Sterile dressing applied. Transferred after 6 hours to base hospital where the burn was treated by Bunyan Stannard bag method. Discharged on 37th day after injury. Wound completely healed and functional result excellent.

Case No. 39:—William . . . . aged 37, Auxiliary Fireman. Severe second degree burns both legs and both aspects of trunk due to being trapped in a burning building. First seen 2 hours after injury. Condition on admission desperate. Pulse uncountable and almost imperceptible at the wrist. Given 1000 cc. filtered plasma rapidly. Very slight temporary improvement. Plasma continued as slow drip. Oxygen administered by B.L.B. mask. Condition steadily deteriorated and patient died 5 hours after admission.

Case No. 54:—Ethel M. . . . aged 28 years, Laundress. Multiple small but deep burns of arms and lower parts of both legs due to splashing with drops of burning oil from an oil bomb which fell some distance away from where she was standing. First seen one hour after injury. General condition good. No obvious signs of shock. Pulse 100, systolic blood pressure 125 mm. Given gr.  $\frac{1}{4}$  morphia intra-muscularly and one pint of hot sweet tea. After a period of rest of 4 hours the burned areas were carefully cleaned up without anaesthesia and treated with triple dye. Discharged to

care of her own doctor after 18 hours, her general condition being excellent.

Case No. 73:—James F. . . . aged 46. Fireman. Scorching of face following opening the door of a room which was on fire. First seen 3 hours after injury. General condition good, but patient, who had been on continuous duty for 36 hours was exhausted. Given gr. 20 Chloral Hydrate and grs. 30 Potass. Bromide and put to bed. Face treated with Cod Liver oil mask. Patient detained 36 hours for observation after which discharged to return to duty.

Case No. 81:—Joyce R. . . . aged 23, rubber worker. Second degree burns of front of chest due to clothing igniting following explosion of thermite bomb in her home. The clothing was rapidly removed by her sister which no doubt prevented more serious injury and probably saved her life. First seen three-quarters of an hour after injury. General condition then quite good. Pulse rate 100. Systolic Blood pressure 130 mm. Given gr.  $\frac{1}{4}$  morphia and one pint of hot sweet tea and placed in observation ward. One hour later her condition was obviously deteriorating. Pulse rate had risen to 135 and Systolic Blood Pressure fallen to 95 mm. She was therefore given 500 cc. filtered plasma which restored the blood pressure to its former level. The burns were then cleaned under gas and oxygen and treated with triple dye. Progress was maintained and she was sent to base hospital after 48 hours. Finally discharged after a further period of 32 days. Condition on discharge good.

Case No. 84:—Charles G. . . . aged 51, First-aid party worker. Second degree burns dorsum of right foot and half way up right leg, due to foot and leg passing through a burning floor board. First seen one and a half hours after injury. General condition not good. Skin pale, Pulse 107, Systolic Blood Pressure 95 mm. Anxious and restless. Given gr.  $\frac{1}{4}$  morphia intra-muscularly and one pint of hot sweet tea. 500 cc. filtered plasma given in about 20 minutes. Condition much improved. Systolic Blood Pressure now 115 mm. Surgical toilet under open ether and burned area treated with triple dye. Additional 500 cc. filtered plasma given by drip on termination of above treatment. Transferred to base hospital after 48 hours. Discharged to his home on 37th day. Burned area healed and general condition good.

Case No. 95:—Mary McM. . . . , aged 74. Severe second degree burns of leg and trunk result of clothing becoming ignited when her home was hit by several incendiary bombs. First seen one and a quarter hours after injury. Pulse almost imperceptible at the wrist and uncountable. Sighing respirations. Not conscious of pain. Quite clear mentally, 1,000 cc. of filtered plasma transfused into median cephalic vein in about half an hour. Pulse a little better. Systolic Blood Pressure 80 mm. No attempt was made to deal with the injury. Plasma continued by drip but condition of patient steadily declined and she died 6 hours after admission.

Case No. 119:—Ethel M. . . . , aged 16. Rubber worker. First degree burn right forearm with some blisters and one small area second degree. First seen 8 hours after injury. Burn cleaned without anaesthetic and treated with paraffin wax. Attended as out-patient for 16 days by which time the burned area had completely healed. Instructed to report after one month for observation, which she did. No visible scarring.

Case No. 137:—Roger J. . . . , aged 37, Tram driver. Severe burns of left foot and ankle. Deep charring of muscle tissue and possibly of bone. The ankle had been trapped under some burning furniture. Also crush injury of right leg and incised wounds head and shoulders which had apparently bled freely. General condition very poor. Extreme pallor, pulse feeble, 140 per minute. Systolic Blood Pressure 70 mm. Given gr.  $\frac{1}{2}$  morphia intra-muscularly and hot sweet tea followed immediately by 1,000 cc. whole blood rapidly administered. Condition improved. Pulse 120. Systolic Blood Pressure 105 mm. At this stage it was decided to amputate the injured part, and this was done under gas and oxygen at the site of election below the knee. The wounds of the head and shoulders were dealt with at the same time. Plasma was continued throughout the operation as a slow drip. Condition after operation fairly satisfactory. Returned to bed with shock cradle and filtered plasma continued as slow drip. In spite of the severe nature of his injuries and his bad condition on admission he made steady progress and was transferred to base hospital on the 8th day after operation. Finally discharged from base hospital after a further period of 37 days general condition being good.

Case No. 164:—Jean F. . . . , aged 17. Rubber worker. Small areas first degree burns face with about 8 small blisters. Isolated small burns chest due to being trapped for a short time in a burning building and hit by flying sparks. General condition good. Given gr.  $\frac{1}{2}$  morphine and one pint of hot sweet tea. After 3 hours' rest burns on face treated with paraffin wax. Burred patches on chest treated with gentian violet jelly. Discharged to care of own doctor after 36 hours.

Case No. 229:—Walter B. . . . , aged 5 years. First degree burn both buttocks. Reddening of skin with one or two small blisters. First seen 3 hours after injury. General condition good but very frightened. Given 10 gr. Potass. Brom. by mouth and hot drinks of glaxo sweetened with glucose. Blisters aspirated and cod liver oil dressing applied to burned area. Discharged to care of own doctor after 24 hours.

Case No. 253:—John W. . . . Insurance agent. Extensive second degree burn of posterior aspect of thorax due to falling among some burning debris. Whole burned area filthy with dust and debris. First seen half an hour after injury. General condition then fair. Given gr.  $\frac{1}{2}$  morphia and one pint of hot sweet tea. Pulse 130. Systolic Blood Pressure 90 mm. Given 1,000 cc. of filtered plasma after which Blood Pressure arose to 120 mm. Burned area thoroughly cleansed under open aether. Plasma continued by drip. Condition after operation good. Systolic Blood Pressure 120 mm.

In view of the extremely dirty condition of the wound it was dusted with sulphanilamide powder and treated with saline packs. On the second day saline packs alternating with eusol packs were substituted. General condition remained fairly good. On the fifth day after injury deterioration set in and signs of broncho-pneumonia appeared in the chest. This was treated with sulphapyridine and subsided. After a further period of 14 days a clean granulating area about 8 inches by 6 inches was available and this was treated with thick skin grafts taken from the leg. He was finally discharged in good condition 51 days after the original injury.

Case No. 267:—Elizabeth S. . . . , aged 32. Machinist. Second degree burns palmar surface right hand. First seen one hour after

injury. General condition good. Pulse 100. Systolic Blood Pressure 125 mm. Given gr. 4 morphia intra-muscularly and one pint of hot sweet tea. Allowed to rest. After 2 hours condition still good. Burned area cleansed under

gas and oxygen and triple dye applied. Discharged to her home after 48 hours and told to attend for dressing. Discharged healed on 29th day after injury. Functional result excellent.

## INFECTIONS OF THE FOOT

### CLINICAL ASPECT

*(Continued from previous issue)*

The following is a working classification that has been adopted for studying the infections of the foot:—

- I. Whitlows—infective conditions of the same type as are observed in the hand. Superficial in one of the layers of the skin, the nail being considered as part of the epithelium.
  - (a) Phlyctenoid or subcuticular whitlow.
  - (b) Periungual whitlow or paronychia.
  - (c) Sub ungual—Onychia.
- II. Acute spreading infections.
- III. Deep infections.
  - (a) Whitlow of the pulp.
  - (b) Cellulitis.
  - (c) Gangrene.
- IV. (a) Abscesses of the foot—
  - (1) With reference to foot spaces;
  - (2) Special types of abscesses—abscess heel, collar-stud abscess, etc.
 (b) Osteomyelitis.
- V. Synovial infections—
  - (a) Acute; and
  - (b) Chronic.
- VI. Lymphatic infections.

- VII. (a) Ulcers—tropical ulcers, Naga sores, chronic ulcers.
- (b) Fungus infections.
- (c) Mycetoma Maduræ.
- (d) Corns and callosities.
- (e) Infected bursa.
- (f) Ingrowing toe nail.
- (g) Arthritis.
- (h) Ainhum.

### I. SUPERFICIAL WHITLOWS.

Infections that occur in different layers of the skin including those which affect the nail bed, because the nail is modified epidermis, are dealt with in this group.

(a) Phlyctenoid or subcuticular whitlows:—Most of the subcuticular whitlows develop as shoe bites. The usual situation is over the dorsal aspect of the toes, the posterior aspect of the heel and the inner part of the foot. They are the result of friction between the newly worn shoe or the straps of the chappal and the skin. When the leather used is rough or if socks are not worn there is much friction between the foot and its wear which results in these shoe bites. They start as blisters wherein there is collection of serum which raises the epidermis from the dermis. These may get infected secondarily and form a pustule. If the shoe or sandal is discarded as soon as a blister develops the process may subside with

it; otherwise, the blister may burst and get secondarily infected. These subcuticular whitlows start also after injury in the toes, more frequently in the great toe. In these cases the progress is the same as before but there is the danger of spread of infection to the superficial or sub-cutaneous cellular spaces leading to cellulitis and in some debilitated individuals to gangrene.

Treatment consists of early snipping of the blister and dressing with streptocide or 1% aqueous solution of gentian violet. The wound heals in 7 to 10 days.

Paronychia of the toes has the same clinical features as that of the fingers described by Kanavel. To start with, there is a small bead or two of pus collected in the subcuticular tissue on one side of the nail. When neglected it spreads along the side of the nail and back to the base becoming secondarily a typical 'run-round'. Sometimes the infection spreads from one side of the base of the nail to the other lifting the nail completely off its matrix and finally the nail is cast off, or detached all along its base. Sometimes the soft and delicate nail root under the eponychium is raised entirely off the nail bed although the



Figures 24 and 25

#### Subcuticular Whitlow.

(b) **Periungual whitlow or paronychia:**—This variety of whitlow is very common and begins usually on one side of the nail as a simple infection in the superficial layers of the skin. It is generally due to some slight injury such as brushing against a stone. As people walk barefooted, dirt accumulates round about the nails between the nail and the epidermis, particularly under the overhanging nail, between it and the skin margin. The injury acts as an exciting cause and infection readily starts. Sometimes, it is found in association with ingrowing toe nails.

distal exposed portion of the nail might still be attached to the matrix.

Treatment is on the same lines and principles as that of paronychia in the hand. Evacuation of pus in the early cases followed by aseptic dressings is sufficient. If it is a 'run-round' two separate incisions have to be made on either side parallel to the side of the nail sulcus. If the pus spreads under eponychium the following procedure is adopted as in the case of the hand. The incision is so made that a rectangular flap of skin with a proximal base

is fashioned. It is first made transverse 2 mm. proximal to the nail. It is then branched upwards on each side at a right angles to the first incision, while keeping parallel to, but outside, buried edge of the nail. The skin flap is raised by knife dissection which exposes the lesion. The upper part of the nail is detached. If the distal part is still adherent the proximal detached portion has to be scissored and removed leaving the adherent portion in place. "Ring" anaesthesia as advocated by Iselin can be used with advantage. Recovery is prompt and it takes about a week or 10 days for the wound to heal.

(c) Sub-ungual whitlows:—These are common in the great toes. The usual history is that of a weight falling directly over the great toe or stubbing of a toe on the roadside resulting in sub-ungual haematoma. This offers

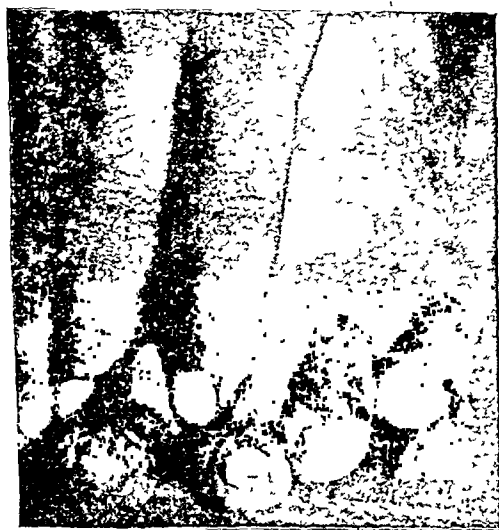


Fig. 26  
Paronychia—II Toe, Lt. Foot.

a good focus for infective organisms and pus collects. The usual symptoms and signs of pulp infection such as, throbbing pain in the great toe, tenderness, warmth, swelling and redness in fair-skinned people will be met with. If it is treated at this stage by effectively letting out the pus, it heals quickly. Otherwise, the infection spreads under the nail involving the whole nail bed. Pain is very severe and the patient cannot walk. After a day or two it bursts at some para ungual point—usually,

at its distal free portion—pus escaping in small beads but insufficiently. The symptoms are now less in severity, but the pain and tenderness persist on walking. The infection ultimately travels down via the lymphatics to the periosteum and sets up an osteitic reaction, the diaphysis finally separating as a sequestrum.

**Treatment:**—"Ring" anaesthesia. Incision and letting out of pus at the point of maximum tenderness. A triangular piece of that portion of the nail over the area involved is excised in order to expose completely the focus of suppuration. Healing is rapid, and the nail grows without any deformity. Most of the cases that

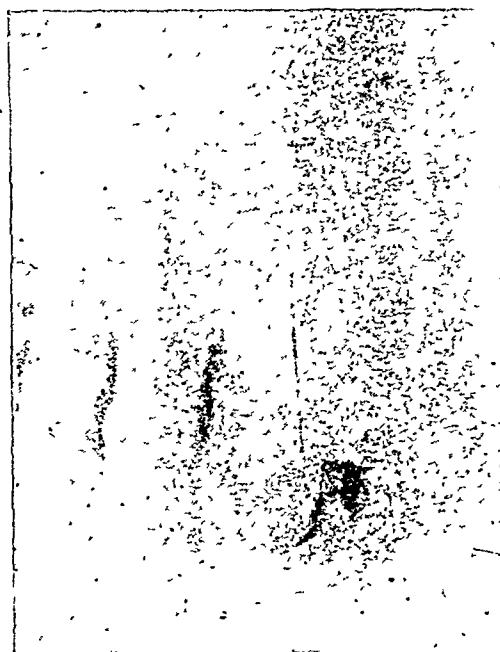


Fig. 27  
Onychia.

come to the hospital are in the last stage, complicated with osteomyelitis. The treatment at this stage is different and is dealt with later.

## II. ACUTE SPREADING INFECTIONS.

Under this head come infections which involve both the skin and the subcutaneous cellular tissue. It is neither pure lymphangitis nor frank fascial space infection. It is differ-



Fig. 28  
Before Treatment



Fig. 29  
After Treatment

**Acute Spreading Infection  
Left Foot and Leg.**

ent from lymphangitis in that the skin also is involved in the inflammatory process.

Similar clinical manifestations also occur in the upper limb. The course of the disease varies. It may be a fleeting lymphangitis; or it may be accompanied with formation of distant abscesses. Filarial infections are excluded from the purview of this paper as they form a distinct clinical entity though some of the manifestations may be of the type described below:—

“R.N. 75 years—3 weeks before admission patient developed a swelling of the left foot. He is unable to remember or give any history of trauma. The foot was painful. He could not bear weight nor walk since a week. Started with irregular bouts of fever. Examination revealed diffuse swelling of the whole of the leg below the knee. There were three blebs over the region of the outer malleolus and distal to it on the foot. There was one big bleb near the heel on the inner aspect. Distal to this

bleb the skin was erythematous and there was another bleb in the calf. The plantar aspect of the heel and the sole were free. Skin over the leg was granular to feel and also to appearance. Lymphatic oedema of the whole of the foot and leg. The knee area above was free. Groin glands, tender, warm and discrete.”

General condition was fair, temperature 99.8°, tongue coated slightly; patient had bronchitis in addition. Blood showed leucocytosis. Urine free from albumin and sugar.

**Treatment:**

The blebs were laid open and the reddish brown patch of the skin and the loose epithelium excised. Wounds were dressed with streptocide. Intravenous glucose administered to combat toxæmia. Cibazol by mouth, 1 gramme 3 times a day, was given for 4 days, the total quantity given being 12 grammes. Smears made from the discharge revealed streptococci



and staphylococci. A swab taken for culture grew both strepto and staphylococci.

The swelling came down on the third day within 48 hours. Later the wounds were dressed with one per cent. aqueous Gentian Violet once a day. The general condition markedly improved by the third day, and there was no rise in temperature.

The patient was discharged on the 12th day, the wounds all healed. He reported in person six weeks later. He has no disability with regard to locomotion or weight bearing.

#### CLINICAL FEATURES:—

The initial lesion is always small. A scratch or a pinprick which, in the majority of cases, is situated on the dorsal surface. The incubation period is short. Signs of infection develop within a few hours. In other cases the infection may appear to follow a mild course and then quite suddenly and on account of secondary infection or trauma, the condition worsens in a few hours.

— The skin of the foot and leg up to the knee presents a shining appearance. Infiltration of the tissue begins and is more prominent on the dorsum of the foot and anterior aspect of the leg due to the looseness of the subcutaneous cellular space. On palpitation, the skin has a granular feel, the movements of the joints are limited on account of the swelling and pain. There may be regional lymphadenitis.

**COURSE OF THE DISEASE:—**Severe cases end fatally within a fortnight.

"A young boy had a prick in the heel with a nail; 7 days later he was brought in very ill and toxic with intense swelling of the dorsum of the foot and leg, and showing pus pockets in the heel at the site of the original wound. The pus pockets were drained well. Two days later he rapidly developed gangrenous patches in the heel and around the posterior and lateral aspects of the ankle. Excision of these patches of skin was done and the wounds dressed with streptocide. Streptocide was given orally also but the patient showed no improvement and the gangrenous process in the wound spread. He died of toxæmia on the 13th day of the disease and on the 6th day of admission."

In some cases the lesion is not so extensive and severe. The gangrenous process is localised and destroys only a part of the skin. If these cases are tackled early they turn favourable and improve steadily though slowly. It takes nearly seven to eight weeks for these patients to get back to normal work.

**Treatment** is mainly general till infection gets localised. General treatment is to maintain the strength of the patient by all available means. The use of Chemotherapeutic drugs, sulphonamides orally or even parenterally in severe cases is commended. Toxaemia should be combated by giving glucose and saline intravenously. Severe cases can be treated with penicillin particularly if the case is sulphur resistant.

**Local Treatment:—**The wound of entry is examined, opened and excised. During observation any collection of pus in a local area should be let out ensuring good drainage. If gangrene develops, it should be allowed to localise before it is excised. All procedures should be aseptic. Once the infection is controlled, the limb is rested in a plaster splint, the wounds being dressed once in 3 or 4 days or at longer intervals.

### III. DEEP INFECTIONS.

#### (a) Whitlow of the pulp of the toes:—

Corresponding to the whitlow of the finger, they are sometimes found as a result of accidents—crushed injuries or open wounds or a thorn prick or a glass cut. Blood borne infections are uncommon and when they do occur they are of the same type as those in the fingers and the treatment also is the same. The incidence is very low when compared with that of the fingers. There was only one case in the whole collection of the cases and is described below.—

"Mrs. A. S. R., H. F. 35 years, developed boils over the forehead, nose, chin and the body diffusely. She was given sulphonamides for that condition. Five days later as the boils were subsiding she developed pain of a pricking nature in the right great toe. The pain grew worse in three days' time, when she came under our observation. The great toe was slightly swollen, and very tender in the plantar aspect. There was a subcuticular abscess

in the outer aspect of the under surface of the great toe. The pus was let out and dressed with streptocide powder. She was put on cibazol gm. 1. three times a day. The pain did not subside but, on the contrary, increased; it was throbbing in nature and the patient could not sleep at night. On the third day, pulp infection was diagnosed, and under general anaesthesia an incision and a counter-incision made as for pulp infection of the thumb; about  $\frac{1}{2}$  cc. of pus was let out and through and through drainage effected. The pain came down the next morning. The drainage tube was removed on the third day after incision. Warm saline baths and streptocide dressing were given for ten days, when the wound was healthy and there was no more pus. Later the wound was dressed on alternate days with 1% aqueous gentian violet. The wound healed in 27 days."

#### (b) Cellulitis:—

Most of the infections of the foot start in the toes, or proximal to their bases on the plantar aspect. The later course, however, depends on the routes of spread and the virulence of infection. The routes of spread are:—

- (1) Fascial spaces,
- (2) Lymphatics and
- (3) Both.

If the spread is by fascial spaces it results in local inflammation and cellulitis around the seat of lesion. The spread is fairly slow and and if virulence is not severe and relief comes early, the resolution is complete and loss of tissue and function is very little.

If the spread is by lymphatics there develops lymphangitis, lymphadenitis and, in unfavourable cases, septicaemia and even death. This kind of infection is the most serious as regards immediate mortality, but once the crisis passes, is the least apt to cause permanent disability.

The infection spreads by both the routes in "acute spreading infections of the foot" wherein there is local inflammatory reaction with cellulitis and distant metastatic formation of an inflammatory focus leading to suppuration somewhere along the course of the lymphatics that drain the area. In severe cases, there is severe general reaction and the

inflammation at the original seat of infection may lead on to gangrene. This variety of it, has already been described to some extent and more will be said about it later.

Frank cellulitis with local spread, or general reaction or spread by the lymphatic route, is rare. When the infection is of a mild degree and when the patient happens to be a diabetic, or has albuminuria it spreads along the fascial spaces, fairly rapidly. If treatment is given early in the course resolution is complete in spite of the patient being a glycosuric.

"N.P., 50 years, history of an injury 12 days before admission over the plantar aspect of the web between the great and the second toes of the right foot. Two days later he developed a swelling over the dorsum of the foot proximal to the root of the second and third toes. It burst and discharged pus on the fourth day. The wounds were painful since then and he was unable to walk or bear weight on the foot.

On examination, the whole of the dorsum of the foot was swollen. There was a big ulcer on the dorsum of the foot 4" x 1 $\frac{3}{4}$ ", irregularly ovoid with pink elevated edges, pus oozing out and lots of slough exposed. Some areas of the edge of the ulcer showed greyish black slough turning gangrenous (?). There was a wound in the sole at the root of the second toe discharging some pus. General condition fair; urine—sugar about 1 per cent., phosphates plus; albumin nil.

**Treatment:**—Without anaesthesia—debridement of the wound, sloughs removed. Dressing with streptocide was given. The foot was elevated on pillows to facilitate drainage. Insulin was given to regulate glycosuria. The ulcers improved and were healthy looking and the swelling over the dorsum of the foot disappeared by the fourth day. 12 days after admission, he developed two abscesses over the dorsum of the foot, one at the base of the first metatarsal and one distal to the medial malleolus. These were opened and drained. 20 days after admission all the wounds were healing well. All the ulcers healed and he went home walking. He stayed in the hospital for two months."

## (c) Gangrene:—

Gangrenous infections of the foot are very common. The foot is the seat of pathology in the case of senile gangrene. Here, the gangrene is usually of a dry type and infection is minimal. It is chiefly due to impoverished blood supply of the foot due to arterio-sclerotic changes, particularly in the smaller arteries of the foot, generally the big toe. The gangrenous process may commence after a slight trauma when there develops a small ulcer with a central black necrotic area. This process may slowly progress and lead on to inflammatory senile gangrene. It may also start as a result of a thrombus forming in and occluding the tibial vessels, when the toes begin to shrivel up and die without any evidence of local inflammation. Pain is a marked feature and as the disease spreads it becomes unbearable and the patient gets insomnia and exhaustion, unchecked. The termination is fatal and may be hastened by septic fever, bed sores or pulmonary, cardiac or renal complications.

Treatment is invariably amputation, once gangrene sets in. The level of amputation has to be decided so as to be well away from the seat of necrosis ensuring the circulation of the flaps of the stump. If a major part of the foot is involved it is generally done through the lower one third of the thigh. If the general condition does not permit of an amputation, the affected area is protected by a dressing to prevent the access of sepsis and the general condition improved by suitable tonics, nourishment, stimulants and analgesics to ensure sleep.

The other main types of gangrene may be classified as follows:—

- (1) An acute spreading infective condition ending in gangrene formation;
  - (2) Diabetic gangrene, and
  - (3) Gangrene secondary to infection after crushed injury or compound fracture.
- (1) Some of the cases which start as 'acute spreading infections' on localisation develop gangrene. Sometimes, it happens that a simple infection of the toe after an injury passing through a fairly normal course suddenly becomes gangrenous over a more or less extensive area. There must be occurring

arterial thrombosis which comes on without apparent cause and without warning. The general health of the patient does not appear to be of any special significance. However, diabetes seems to have a role in the development of the gangrene.

"J.W., A.I. 45 years, developed two shoe bites one on either margin of the right foot. He could not discard the shoes nor could he give rest to the foot. In one week, the whole of the foot swelled up, became painful, and he could not walk.

On admission, the patient was toxic, temp. 100° F., with moderate general condition.

The whole of the dorsum of the right foot and the lower 2/3rd of the right leg were swollen. The one shoe bite wound at the root of the little toe contained a bead of pus while the other had already healed up under a scab.

In the centre of the swelling in the dorsum of the foot, the skin was dark over an area 2" x 1½" with sub-epithelial collections of lymph at the periphery. Lymphatic oedema of the tissues was present up to the junction of the middle and upper 1/3rd of the leg. Glands in the groin enlarged; tender, showing evidences of inflammation. Urine free from sugar and albumin.

**Treatment:** Without anaesthesia the blebs were laid open. The necrotic patch of the skin was cut out, sloughs beneath the skin were removed as far as possible using gentle traction. Wound was dressed with streptocide and bandaged and limb kept elevated resting over pillows. Smear of pus with gram's stain revealed streptococci. Culture report was "Haemolytic streptococcus grown in culture" Patient was put on streptocide gm, 1 thrice daily.

The next day general condition showed definite improvement. Plenty of sero-sanguinous discharge was oozing out of the wound. In ten days, swelling came down completely. The wound was regularly dressed with streptocide once in three days. A month later, the wound was clean granulating well, and showing epithelialisation.

## (2) Diabetic gangrene.

Gangrene of the lower extremity in the diabetic manifests itself in two forms:--

- (a) The uncomplicated ischaemic necrosis, typical of the non-diabetic arteriosclerotic, commonly termed 'dry gangrene'; and
- (b) The septic necrosis known as 'moist gangrene' which takes place in the presence of fairly good blood supply to the limb.

The dry variety is the senile type when gangrene sets in in a limb where the blood vessels have been grossly narrowed down and the collateral circulation not well formed.

The latter condition is not a result of vascular occlusion but of the culmination of a series of changes. Slowly progressive intimal thicken-

ing permits the development of collateral circulation until eventually a delicate balance between life and death of the tissues is reached. When gangrene occurs it is more often the result of increased demands of the tissue cells due to the metabolic disturbances of sepsis and diabetes than to an immediate decrease of blood supply. Local bacterial invasion initiates or attends the development of this process and soon becomes the dominating figure. The combination of sepsis and persistent but inadequate blood supply result in a moist spreading gangrene, which, untreated or unchecked, causes death. If the tissue metabolism be returned to normal the blood supply would again be adequate and the necessity for amputation as a primary therapeutic measure become less. So in the presence of a spreading gangrene if infection be eliminated and the diabetes with its disturbed metabolic process

## Acute Spreading Infection, Foot, Ending in Gangrene.



Fig. 30

Note the intense lymphatic  
Oedema with central necrosis.



Fig. 31

After debridement swelling disappeared  
wound granulating well.

and abnormal cell needs be controlled, the gangrene would not recur.

In the first variety the patient gives a history of intermittent claudication a short time before the onset of actual gangrene. The pain is severe, burning, or shooting in character and out of all proportion to the extent of the lesion. The pulsation of the dorsalis pedis and the popliteal as well may not be felt. The difference in temperature between the limbs is apparent, the affected limb sometimes feeling actually cold.

The circulation being poor and the pain very severe, it is ideal to do a high amputation through the leg or lower 1/3rd of the thigh in this dry type of gangrene as early as possible.

In the other variety the history of the intermittent claudication will be of a long duration and the pain not so severe. The popliteal and the dorsalis pedis do pulsate and the warmth of the affected limb not much diminished.

**Treatment:**—Essentially falls under two heads:—



Fig. 32.

Diabetic Cellulitis and Gangrene.

(1) **General.** Rest in bed. Restoration of normal protein and plasma level by transfusion and by giving plenty of fluids by bowel and by mouth.

One should not worry much about the blood sugar level to be brought down very quickly. Diet with plenty of carbohydrates, moderate supply of protein and minimum of fats to be given.

Insulin and protamine zinc insulin are to be given to regulate the glycosuria. If acetoneuria is present glucose should be administered intravenously supplemented by insulin.

Chaemotherapeutic agents like sulphathiazol in fairly massive doses help towards controlling and bringing down the infection. They should be continued till three or four days after the infection is brought under control.

Penicillin, 15 or 20,000 units, every three hours given intramuscularly as an adjunct to local surgical treatment is of immense help towards rapidly controlling the infection. After the advent of penicillin the progress of these cases is very good.

## (2) Local.

(p) Prevention of extension of local infection by keeping the limb horizontal in bed (not elevated) and at rest, the part being periodically irrigated with eusol solution. The part is then kept covered with sterile gamgee pads only. This helps towards localization of the infection and separation of sloughs.

(q) Removal of gangrenous area—This is a slow and prolonged process. The sloughs as they separate are removed applying very gentle traction, every time removing as much as possible.

(r) Stimulation of circulation and of growth of granulation tissue and new epithelium. The following are advocated and found useful:

- (1) Intravenous injection of 5% saline or glucose about 50 c.c. a day.
- (2) Nicotinic acid tablets by mouth—massive doses.
- (3) Perandrin—subcutaneously once in 2 or 3 days.
- (4) In the later stages, U.V. ray exposures to the wound.

**(3) Traumatic Gangrene:—**

Gangrene secondary to crushed injury and compound fracture—In this variety, if gas gangrene is excluded the aetiology of the ordinary gangrene is not well understood. It is supposed to be due to a more or less synergistic action of strepto and staphylococcus. The streptococcus is the main aetiological factor to start with, the staphylo appearing after the gangrene has manifested itself. And it is the staphylo that persists in the latter part of the course.

In this group there is damage to soft parts and blood vessels and nerves resulting in direct infection. With loss of blood supply and also poor venous return, gangrene readily manifests itself and loss or damage to tissue is often extensive.

**treatment:—**(i) Prophylactic—All crushed lacerations and compound fractures should be well exposed under anaesthesia, thorough excision of devitalised and ruptured vessels identified and tied. The wound should be etherised and freely plastered with streptocide and closed leaving a good sized drainage tube or two as the case demands; the drainage tube always should be brought out through a separate stab incision in the skin at the dependant part of the wound. Tension in stitching is to be avoided. If unavoidable relaxing incisions may be made or the wound left packed, not sutured. Reparative surgery can be thought of after the wound has healed or after all danger of infection is over. The limb should be immobilised in plaster.

Preliminary A.T. serum 3,000 units and A.G.G. serum 4,000 units should be given for all cases.

(ii) Curative—When the case comes late and infection and gangrene threaten, formal debridement of the wound or, better, an enlargement of it so as to facilitate free drainage, should be done. Sulphanilamide groups of drugs are to be widely used by freely applying it locally and by mouth or even by injection. In case of severe infection or gross contamination or extensive involvement of the extremity penicillin will be the ideal drug to be used. If in spite of all these efforts gangrene supervenes or the case comes with gangrene already set in elective amputation is imperative.

Among other varieties, gangrene due to (i) Embolism and thrombosis; (ii) Thromboangitis obliterans and (iii) gas gangrene will be considered now.

(i) Embolism and thrombosis. The common source of an embolus (simple) may be due to the separation of a vegetation from one of the cardiac valves or possibly an atheromatous plaque from the aorta or one of its main branches, or a mural clot detached from the left auricle during an attack of auricular fibrillation. The other types of emboli are infective embolus, malignant embolus and the parasitic embolus. The gangrenous process slowly spreads and finally stops at a level where the circulation is intact and sufficient. It generally involves the whole foot and demarcates slightly above the level of the ankle joint.

Treatment is amputation after the line of demarcation has established itself. Till then aseptic conditions should be maintained in the affected part. If the part becomes infected, amputation should be done at a higher level.

(ii) Thromboangitis obliterans:—The gangrene that follows this affection, is never an extensive one, and by itself not a distressing one. It starts long after the impoverishment of blood supply establishes itself. It is the cramp-like pains even after slight exercise and recurrent or continuous pain due to involvement of nerves in the perivascular fibrosis that is distressing. Phlebitis of superficial veins adds to the discomfort.

**Treatment—**(1) Eschewing of tobacco; (2) Intravenous glucose 5% solution; (3) Exercises to the limb to improve circulation; (4) Sympathectomy—either lumbar or periarterial of the femoral artery in Hunter's Canal. The last method has given very good results in many cases and helps in the healing of the ulcer. The gangrenous process usually involves a small area. After sympathectomy, a debridement should be done and the wound dressed only once in a week. Simple dressings with 1% aqueous gentian violet are quite sufficient. The wound heals very slowly.

(iii) Gas Gangrene. Though rare it is often the fatal sequel to many a roadside injury. Any extensive accidental wound, be it a crushed injury with extensive laceration or a compound fracture, or a compound fracture with

a punctured wound, if contaminated with garden soil is liable to have gas gangrene develop in it. Extensive haemorrhage with blood clots in the wound and much lacerated tissue, particularly muscle, are the necessary media in which the causative organisms thrive and multiply with rapidity. These organisms fall under two groups, the saccharolytic—*B. Perfringens* (Welchii) and Proteolytic—including *B. Sporogenes*, *aerogenes capsulatus* and *oedematis maligni*. Owing to the lysis these organisms set up all the tissue is dissolved and gases emanate, the final ones being carbon dioxide, hydrogen and hydrogen sulphide. The last is responsible for the offensive odour associated with it. The infection spreads rapidly along the muscle fibres, groups of muscles being attacked simultaneously.

The clinical features develop within 48 hours after the occurrence of the incident. The actual signs are those of toxæmia—a rapid pulse with a rise or in severe cases a fall in temperature and vomiting. The toxins are supposed to exert a depressing effect on the suprarenals resulting in a fall of blood pressure and consequent vomiting; swelling is greater than usual and the pain more than what the injury would indicate. There is marked mental alertness. The muscle colour and appearance vary but changes are always present. It loses its healthy red appearance and swells up. It is puffy and dull red in colour. The colour changes rapidly to green and then to brown and black. When it is black it loses all its structure. It is disintegrated and is mere foul-smelling frothy mass and no longer muscle. The skin is pale to start with, later appearing brownish. In some cases crepitus may be found on the first day and in a majority the second day and only in a few—later. In the more toxic oedematous cases the crepitus is obscured by the oedema and hence its recognition may be delayed till the second, third or fourth day.

The edges of the wound are of a dirty tint with pouting of the lips. Exudation is not much and is brown in colour becoming offensive in later stages.

Treatment is essentially prophylactic. All wounds are treated on the same lines as those dealt with under the traumatic group of gangrene.

A.T.S. 3,000 units and A.G.G. serum 4,000 units should be given intramuscularly. In all wounds where gas gangrene is likely to develop a careful watch is to be kept to detect its earliest signs. If the infection becomes established, multiple free incisions, local excision of groups of muscle or amputation may be necessary according to the extent and virulence of infection. Amputation stump wounds must be left open and secondary sutures applied after making sure that the infection has been controlled. Drainage tubes should always be left in the wounds.

The sulphanilamide group of drugs have very little or no effect on this group of organisms, but penicillin has a powerful effect.

#### GAS INFECTION:

Sometimes the injury may not be severe and yet the wound may primarily be infected with gas producing organisms. If the wound is only subcutaneous tissue deep and does not involve muscle, these organisms may still thrive as evidenced by the production of gas and crepitus in the surrounding parts. The presence in the wound of foreign bodies devitalised tissue or blood clots due to imperfect or no attention to the wound, inadequate drainage or imperfect debridement definitely favour the survival and growth of these organisms. The gas collects subcutaneously and spreads up slowly in the same plane. Treatment consists in excision of the whole of the skin and subcutaneous tissue involved and dressing with sulphathiazole powder dusted on the wound. Care should be taken not to be too scrupulous in the debridement and not to injure the muscle tissue deep down. Penicillin in 15,000 units doses every three hours given intramuscularly controls the infection readily.

#### IV (a). ABSCESSSES.

##### 1. Abscesses of the Foot:—

The average man in South India goes about bare-footed. As a result of this, the sole of his foot gets thickened all along the area that comes into direct contact with the hard ground. This area includes the region of the heel, that over the heads of the metatarsals and a narrow strip along the lateral border of the foot. Here the epithelium is markedly hypertrophied and presents certain special features. It

cracks all along the heel margins\* and along the inner margin proximal to the great toe. Infection readily spreads down into the deeper layers through this route. Secondly, all over the heel there are found in most of them a number of dark spots which on closer examination are revealed to be either small pittings or deep holes of fine calibre. Infection is very likely to spread down through these. Generally this infection causes a local reaction and it does not easily spread around due to the thickness of the epithelium. An abscess forms and is subcuticular or subcutaneous. The former variety is more common than the latter. The subcutaneous abscess is the commonest in the heel.

### Abscess Heel.

The epithelium of the heel is very thick and presents cracks and fissures with small pittings as described at the beginning of this chapter. The subcutaneous tissue is a thick pad of fat which is firm and granular. It is lodged in the interwoven meshwork of fibrous strands that stretch between the skin and the deep fascia. This subcutaneous space is localised and small. It is only continuous forwards and distally along the outer border of the foot. Any small collection of inflammatory exudate in this area causes therefore intense throbbing pain which can only be compared to whitlow of the pulp of the fingers.

The deep fascia covers the periosteum and the origins of the muscles from the tuberosities of calcaneum and is continued forwards as the slips of the plantar aponeurosis.

Plaster of Paris mixed with glycerine and water is injected to define this space. Very great pressure is required to inject the material into the spaces. X-ray reveals the location of the material and its characteristic granular or beaded appearance and the extent of the heel space. The tendency seems to be to spread out posteriorly where it may get into the sub-epithelial layers and try to burst through or spread up.

The route of infection has always been difficult to assess. But in cases where there are cracked heels it is easy to understand the route of infection. But usually abscesses also

occur in cases where the heel is not cracked and the skin is intact; and it generally happens in accidents in which pressure as on treading over a sharp stone, or a prick by a thorn or a nail, or a glass cut, play their part as predisposing factors and routes of infection.

Owing to the special structure of the subcutaneous tissue even if the quantity of the exudate or pus is small pain is very severe. As this pocket gets filled up, it tries to break through the layers of the skin.

The incision to drain this abscess should always be along the lateral margin of the heel. A counter incision is made on the opposite side and a double drain put in. The drainage tubes should be removed in 24 to 48 hours. Later the case can be dressed with streptocide. From the third or fourth day the pus stops oozing from the wound. The patient should be encouraged to walk bearing weight over the heel after a week. This ensures closure of the pocket and quicker healing. It takes about three weeks before the wound heals completely and the patient can walk freely. If there are secondary blebs they have to be snipped off and dressings with streptocide applied.

Incisions to be made for abscesses in the sole of the foot and the heel in particular should always be in the line of the main vessels and nerves. They should always be in the sides where there is no weight bearing. Wounds of the sole should never be drained or incised through the dorsum of the foot, between the metatarsals as it entails widespread infection. Once incision is made and the wound is healing, the outlying cuticle should never be trimmed or removed. It should be allowed to fall off by itself because it will serve as a protective layer for the new forming skin that is to get accustomed to weight bearing on rough ground.

**Subcuticular abscesses:** They are usually seen at the dorsum of the foot or in the sole. They are generally localised in the thickened epithelium of the sole. They should not be confused with the infective bursa in callosities where similar conditions may be present. Left to themselves they invariably burst and drain automatically. If allowed to burst by themselves they are painful and it is better to open them as quickly as can be done to help rapid healing.

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\* These cracks and fissures in the foot are one variety of cutaneous manifestation of ring-worm in the foot.



**Collar-stud abscesses:** This type of abscess is common in the plantar aspect of the foot over the region of the balls of the toes. Here the epithelium is cornified and dense. It may exhibit cracks in the superficial layers particularly in the labour class. Infection tracks down via lymphatics through those cracks and starts inflammation under the epidermis. It

that is more involved than the subaponeurotic.

The subcutaneous space in the dorsum is generally involved in all types of acute spreading infections leading on to a diffused cellulitis and swelling of the tissues. Once the acuteness of the condition passes off it generally subsides

#### ABSCESS HEEL.



Fig. 33

Note the pittings and the cracked condition of the sole.

finds it difficult to work its way through the thickened layers of epithelium and hence burrows through the dermis and spreads under it thus producing a 'collar stud' abscess. The pain is severe and does not get relieved with mere letting out of pus from the superficial pocket. It requires a deep incision well draining the deeper layer also.

#### (2) INFECTION OF FASCIAL SPACES:

Infection of the various plantar spaces particularly the median plantar spaces is very rare. I have not come across a single case wherein a median space is involved. Of the two lateral spaces it is the lateral plantar space that is more involved but even that is rare. Infection of the inter digital commissures or webs is fairly common and the infection readily spreads to the dorsum and may set up a subcutaneous infection of the dorsum of the foot. Even in the dorsum it is the subcutaneous space



Fig. 34

or gets localised developing a circumscribed area with necrosis and destruction of the skin and subcutaneous tissues often exposing the tendon sheaths in the depths of the wound. This has been dealt with under "acute spreading infection of the foot."

The subcutaneous interspaces are posterior in their situation to the web spaces. Infection in them is localised with lymphatic oedema developing rapidly in the dorsum of the foot. If the virulence of the infection is severe or if the case is complicated with diabetes or albuminuria the infection readily spreads into the lumbrical space and also into the median plantar spaces, M-II, M-III and M-I.

In the diabetic, infection starting after trivial injury to the digits may spread up rapidly

as cellulitis. In some cases the infection travels down to the plantar aspect by way of the lumbricals and tracks down to the median plantar spaces M-II and M-III. Cellulitis in the dorsum of the foot spreads down deep into the sub-aponeurotic space also; it may also be secondary to a spread through the interosseal from the M-III space. The infection is severe and the prognosis is grave, the case generally ending in amputation. In some cases the infection may spread through M-III to the medial M-I space, track upwards and set up distant metastasis in the calf. In others such metastasis may result from tracking up of the infection from the dorsum of the foot along the lymphatics accompanying the saphenous veins to the upper part of the leg or the lower part of the thigh. These are particularly bad cases and in spite of early high amputations the mortality rate is high.

**COMMISSURE INFECTIONS:**—There are commissural or web-spaces between the toes similar to the spaces between the fingers, but whereas there are only three of them between the inner four fingers in the hand, there are four in the foot. Of these, the space between the great and second toes is the biggest and is the one more often involved than the others.

These web-spaces in the foot are bounded on the plantar aspect by the skin, distally by the fold of the skin forming the web, dorsally by the sub-aponeurotic and subcutaneous layers of fascia, laterally by the adhesion of the skin to the pretendinous digitation of the plantar-aponeurosis and proximally by adhesion of the skin to the transverse fibres of the

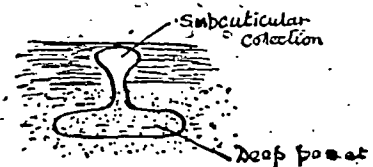
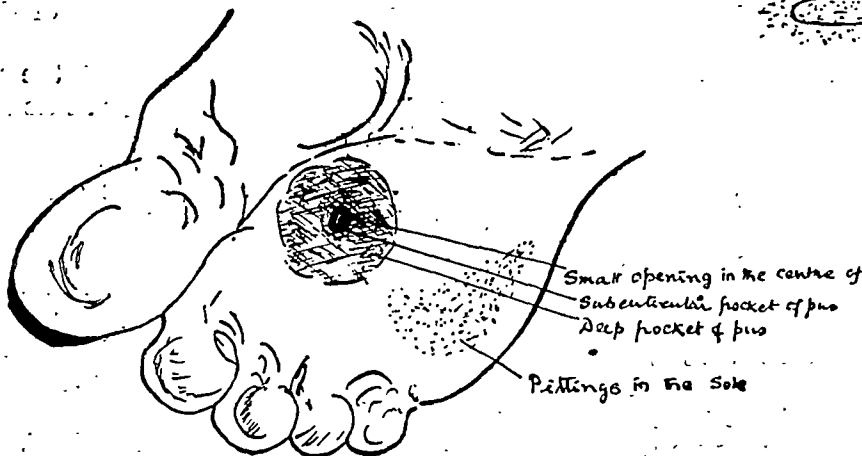


Fig. 35

Fig. 36

### COLLAR STUD ABSCESS

(Explanatory Diagram)



plantar-aponeurosis stretching across the digital slips.

These spaces have no direct connection with the dorsum of the foot by continuity of space. Infection can travel only by the lymphatics which traverse the spaces in their course from the plantar aspect to the dorsum of the foot.

Infection is invariably after a thorn or a nail prick. To start with the pus is localised in the small space described above. From there it spreads to the dorsum of the foot through the lymphatics. In mild cases there is a slight swelling of the dorsum of the foot at the bases of the toes only. But in severe cases the whole of the foot is swollen and an acute spreading infection may supervene. Left to itself the pus breaks through the skin in the plantar aspect.

**Clinical features:**—Pain is localised to the web. There is swelling of the web space with symmetrical swelling of the roots of the adjacent two toes. The movements of these two toes are possible but painful.

Treatment is to let out the pus through a plantar incision with a counter incision through the dorsal aspect of the web. A through and through drainage is to be instituted through these incisions. If the infection spreads to the dorsum of the foot and localises there that cavity has also to be drained.

#### (b) OSTEOMYELITIS.

Osteomyelitis of the small bones of the foot is not very common. It is mostly seen in the terminal phalanges secondary to infection in the soft parts. In crushed injury if the wound were not attended to properly the involved bone may be directly infected with the development of osteomyelitis. Blood borne infection rarely settles down in any of the bones of the foot.

In the terminal phalanges infection may start in the subcutaneous tissue after a slight trauma or it may start as paronychia or onychia. When left untreated the infection involves the nail bed. The nail is shed off in part and the infection becomes chronic. Later it tracks down via the lymphatics and involves the distal portion of the terminal phalanx. It sets up an osteitis and destruction of the terminal portion of the diaphysis. Some of the

patients come at this stage when the digit shows a club-like swelling with ulceration of the whole of the terminal portion. The nail will be missing entirely or in part. There is dark brown or ash grey slough covering the floor and granulations are very unhealthy. Pain will be very severe. An X-Ray shows rarification of the terminal portion of the phalanx. Almost all these cases show, in addition to strepto- and staphylococci, Vincent's spirochaetae and Fusiform bacilli which are associated with tropical ulcer.

**Treatment:**—The wound is dressed with streptocide powder and when it is becoming healthy partial amputation of the digit removing the distal portion of the terminal phalanx leaving the base intact is performed. If the case comes early scraping of the floor of the ulcer and excising the whole of the nail bed will bring about fairly quick healing. In diabetics when the infection in the cellular spaces is severe it may go deep down to the bone and set up an osteomyelitic reaction in more than one bone. In these cases treatment is amputation.

Sometimes, infection may develop in the calcaneus and set up osteomyelitis. These cases may be accompanied by a deep infection in the heel. In treating these cases the heel bone is split in the midline and laid open until the infection is controlled and then brought back and put in plaster in the healing stage, reforming the heel. It gives excellent results.

#### V. TENDON SHEATH INFECTIONS

The tendon sheaths round the ankle are the ones that are more likely to be inflamed. Infection of the digital sheaths is rare. They may be inflamed as a result of injury or get infected by pyogenic organisms, gonococci or tubercle bacilli.

Tenosynovitis may be acute or chronic. Acute tenosynovitis is generally traumatic in origin but is rare in the foot. Acute infective tenosynovitis also is very rare. In some the infection may have been carried by the lymph vessels from an adjacent cellulitis. I have not come across a single case of acute tenosynovitis of any tendon sheath—neither pyogenic nor gonococcal.

Chronic tenosynovitis is invariably tuberculous, the sheaths of the peroneal or extensor

tendons being commonly involved. The disease attacks young adults and may be the only manifestation of active tuberculosis. In the early stages a serous exudate is present, later granulation tissue with the appearance of 'melon seed' bodies; in late stages and in the severe forms extensive caseation may occur. In early cases, the tendons may be thickened as a result of proliferation of their visceral sheaths, but they are healthy. In severe cases a single tendon or a group of tendons may show destruction.

**Treatment:**—If the osseous tissue around is not involved and if the tendons are not destroyed, excision of the diseased portion of the tendon sheaths ensures eradication of the infection. Otherwise the prognosis is very grave.

"Mrs. B. N. F. 22 yrs. admitted for the treatment of pain in the left hæl, duration two months. The pain started as pricking sensation in the outer aspect of the heel and was gradually increasing in severity. She was unable to bear weight on the heel or walk since a week from the date of admission as it caused severe pain. The general condition of the patient was good; cardiovascular and respiratory systems normal. She was pregnant, primi and in the 7th month.

Local examination revealed swelling on either side of the heel below and behind the malleoli, on either side of the tendo achillis. Tenderness was present on deep pressure behind the lateral malleolus. Movements of the ankle and midtarsal joints normal.

Operation on the third day after admission under local  $\frac{1}{2}\%$  novocaine—Kocher's incision. There was a lot of fat behind the outer malleolus. So the tip of the malleolus was raised as a ledge. On opening the tendon sheath it was found to be chronically inflamed. It was excised, wound closed in layers and limb put in plaster.

The pathological report of the excised tissue was that it was tuberculous in nature.

On the 8th day, the sutures were removed. The wound did not take below and behind the malleolus. The wound was dressed with streptocide and leg encased in plaster. Dressings continued once a fortnight though a window cut in the plaster. The discharge was gradually getting less and less. Meanwhile, she delivered full-term, normal labour and the baby was born healthy.

After about six months, she developed tubercular synovitis of the right knee joint. This was also treated on regular lines. Now after 22 months the wound in the left heel is healed and the condition of the right knee very much improved. The case is still under observation."

## VI. INFECTION OF THE LYMPHATICS.

Lymphangitis may be either superficial or deep. Deep lymphangitis may end in tenosynovitis or in abscess formation in the deeper tissues. There is a rapid increase of swelling of the whole of the foot and leg with the greatest redness, swelling and tenderness upon the dorsum. Some red lines of lymphatics may be seen running up the leg to the groin or knee. There is no bulging in the sole of the foot though the concavity of the arches may be lost. The patient usually presents great prostration.

The superficial type shows more or less localised reaction. There is usually a history of abrasion or injury of the foot. In a short time the patient complains of all the symptoms of toxæmia—headache, fever, thirst, restlessness and insomnia. Examination reveals an area of suffused redness, readily appreciated in the fair skinned, with swelling of the toe involved. In acute cases there may be no oedema in the dorsum; but usually the whole of the dorsum of the foot gets oedematous. The lymph vessels pursue the shortest course to the back of the foot as in the hand. And so whether the original site of injury be in the webs between the toes or at the base on the plantar aspect of the toe, the dorsum of the foot swells up. If the infection of the foot is along the outer border of the foot or ankle, the popliteal glands show evidences of inflammation. When it is in the other parts of the foot, the groin glands are involved.

## ETIOLOGY, PATHOGENESIS AND PATHOLOGY OF LYMPHANGITIS.

The portal of entry of the infection is often a trivial wound on the toes, an abrasion or a thorn prick or trauma to the toe nail; or the infection may enter through the fissures in the webs in between the toes and along the heel margins, etc. These fissures are very commonly present in the servant class and the housewife in a middle class household where their feet are wet for over 18 hours in a day. This condition in the foot is worse in winter and rainy seasons. Extension of infection is favoured by neglect of minor injuries, lack of protection against repeated trauma or secondary infection. Rest to the lower limb is a thing which cannot be easily attained as it ensues arrest of locomotion, which is impossible.

The exact reason as to why in some cases only minor injuries are succeeded by lymphangitis, is not well understood. The cause cannot be attributed entirely to poor resistance. It is possible that bacteria causing this condition have certain inherent cytolytic attributes causing a severe reaction.

In most of the cases the bacterium responsible is the streptococcus. The staphylococcus enters the field alone only in a small number of cases. Often both strepto and staphylococci together start the trouble. It is suggested that the streptococcus through its rapid spread prepares the soil for the staphylococcus. When this occurs, the prognosis is more grave since the combination seems to increase the virulence of the staphylococcus.

The local changes at the site of injury may be so trivial as to escape notice. The local reaction even in the most severe case that threaten life may be nothing beyond a simple hyperaemia. The inflamed lymphatic vessels are evidenced by their redness and hyperaemia surrounding them.

**Symptoms and signs:** The patient with lymphangitis ordinarily gives a history of slight abrasion, trauma or thorn prick. Often a history of injury may be entirely lacking. There may or may not be local pain in the foot or leg. Generally there is swelling of the dorsum of the foot with a dull aching pain and in some cases the pain and swelling may be severe. In addition there may be present red lines running up the foot or leg which are

better appreciated in the fair skinned. The patient may present varying signs and symptoms of toxæmia—a chill with high or low temperature, headache, anorexia, and prostration.

The following are the usual types met with in lymphangitis of the lower extremity:—

(i) **Simple Acute Lymphangitis:** The inflammatory process quickly subsides. There is rapid disappearance of all evidences of infection both systemic and local. All signs and symptoms disappear in 24 to 48 hours. The red line of lymphatic inflammation disappears overnight. Slight tenderness over the gland area may persist for a little longer.

(ii) **Acute Lymphangitis with minimal local reaction:**

The subsidence of symptoms is prolonged with delayed resolution or even abscess formation at the site of inoculation or in the gland area. The infection is accompanied by mild systemic symptoms.

(iii) **Acute Lymphangitis with serious local complications or systemic involvement:**

There is severe systemic reaction with local or regional abscess formation. The case may end fatally from severe toxæmia before localisation occurs.

### TREATMENT:—

(i) **Local:** Rest to the limb; patient should be confined to bed. A warm application to the limb—ichthyol in glycerine to be painted over the entire area showing swelling and covered by gamgee pads and held in position by a loose bandage.

(ii) **General:**

(a) Plenty of fluids by mouth to keep the system flushed. In severe cases glucose by the intravenous route as often as necessary.

(b) In toxic cases with dehydration intravenous infusion with saline or plasma.

(c) Nicotinic acid 100 to 200 mgm. a day to combat toxæmia is found useful.

(d) Chaemotherapeutic drugs like sulphathiazole or next in order of preference sulphanilamide up to 4 gms. a day in three or four divided doses till the infection gets controlled.

(e) Food must be easily digestible and sufficiently nutritious.

(iii) If an abscess develops at the site of inoculation or over the regional glands incision and drainage should be instituted after it gets definitely localised. No incision should be made over the dorsum of the foot simply because it is swollen and there is pain. Tenderness localised at a spot and of maximum intensity at that spot locates the pus correctly and not the diffuse swelling, its size or pain. An ill-advised and untimely incision of the same leads to a fatal end.

### CHRONIC INFECTIONS AND REPEATED INFECTIONS

One infection with streptococcus may not immunise the patient. It may seem almost to favour a second at a later date. The patient fails to produce antitoxins in a degree sufficient to overcome the infection.

### FILARIAL LYMPHANGITIS

A patient may be infected with the systemic invasion of *filaria bancrofti*. This parasite may liberate a number of ova which obstruct the minute lymphatics which get blocked and lead to lymphatic obstruction and thickening of the tissue with slight oedema. Under the pressure of the filaria when there is slight slackening of the systemic resistance there may occur a flare up of streptococcal infection leading to acute lymphangitis with severe systemic reaction. Repeated attacks may lead to chronic swelling of the lower limb which may lead on to elephantiasis wherein the skin and subcutaneous tissues all get thickened. This thickening may attain huge dimensions. There is solid lymphatic oedema which does not pit on pressure. The skin itself may overgrow, become coarse and warty. On the surface of the skin will be seen vesicles which are likely to burst and give rise to a troublesome lymphorrhoea. The thick devitalised skin is specially liable to sepsis, chronic ulceration and lymphangitis.

### TREATMENT:—

- (i) Acute lymphangitis to be treated as in any other case of lymphangitis.
- (ii) Later followed by one or more of the various methods employed in combating the filarial trouble which are

- (a) A course of filaria vaccine;
- (b) N.A.B. in 0.15 gms. doses given at intervals of a week on three successive occasions; after a month's interval it may be repeated again. Instead of N.A.B. any other variety of arsenic as filarsan or arseno-typhoid or maphar-side may be given.
- (c) Calcium chloride 5 or 10% solution 5 or 10 cc. given intravenously at 3 or 4 days' interval helps to reduce the swelling of the tissues considerably, in early cases.
- (d) A course of antimony preparation—Bayer's Foudin or Glaxo Laboratory's Fantorin may be tried with much benefit.

(iii) In advanced elephantiasis amputation seems to be the only recourse.

### VII (a). ULCERS.

Trauma and infection due to pyogenic organisms are chiefly responsible for the formation of ulcers in the foot. Prolonged pressure particularly under the heel, due to faulty application of splints and plaster casings, though not so common, also leads to ulceration. The clinical features, pathology and treatment of these ulcers is the same as for those in any other situation.

Of the many other varieties of ulcers there is one chronic type of an ulcer which is generally described as tropical ulcer. It will be considered in detail.

### TROPICAL ULCERS—NAGA SORE.

Among the chronic infections of the foot and leg the naga sore or *ulcus tropicum* is the most important. Though it was originally reported from Assam, it has subsequently been reported from almost all parts of India. It is observed widely in Madras also.

### INCIDENCE:

The following table shows the number of cases of *ulcus tropicum* that attended the surgical outpatient department. The diagnosis was based only on clinical findings which are so characteristic. Hence the number can be taken for all practical purposes to be correct.

Table IV.

Incidence of Tropical ulcers in the Surgical Outpatients Department.

Month & year.		Males.	Females	Total.
		& children.		
September 1943	...	23	10	33
October	"	22	5	27
November	"	30	6	36
December	"	28	8	36
June 1945	...	35	18	53
July	"	42	18	60
August	"	64	9	73
September	"	45	11	56

Of these 30 cases have been picked up at random and at convenience and studied with regard to aetiology, bacteriological findings and treatment.

#### AETIOLOGY.

**Age:** It occurs in any age. But it is more common in adults, the majority being below 30 years.

**Sex:** Both sexes are affected but it is more common in the male; girls are more often affected than women.

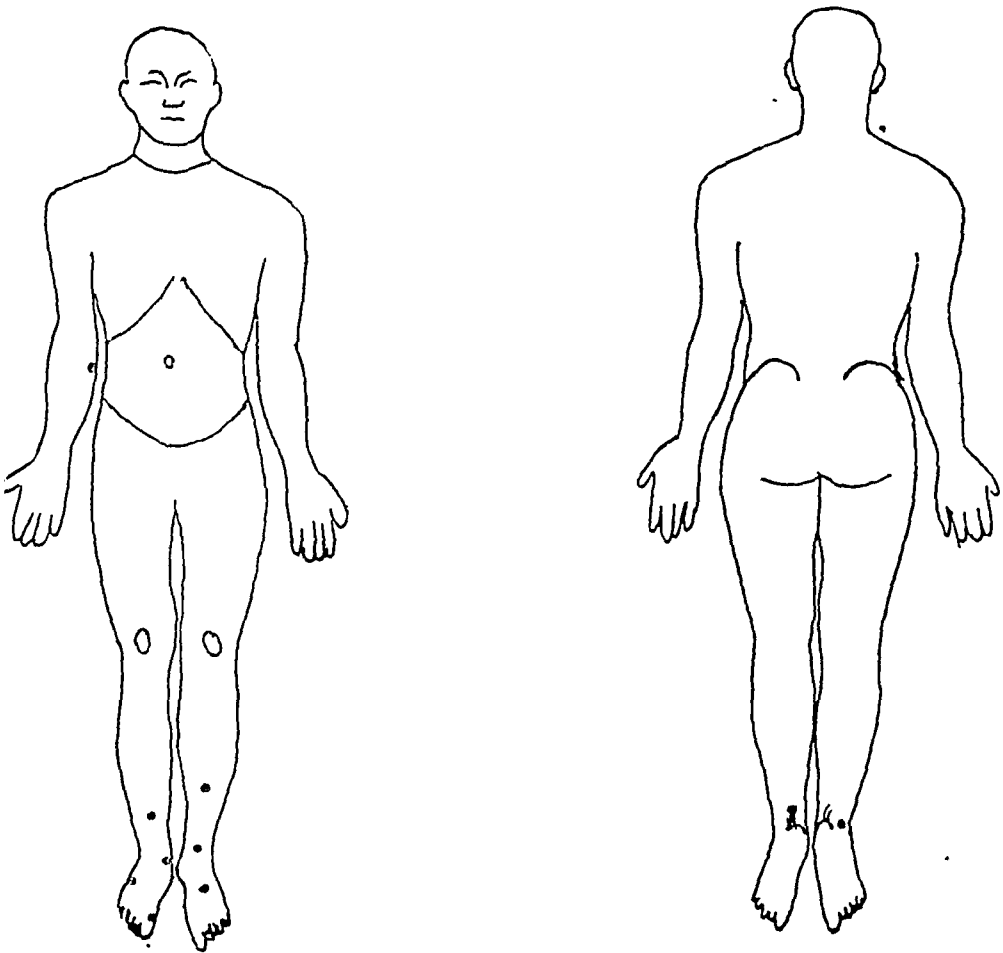


Fig. 37. Usual Sites Where tropical Ulcers Are Found

## Age and Sex Incidence.

Table V.

Age.	Sex.		Total.
	Males.	Females.	
Below 15	- 11	1	12
16—30 yrs.	- 12	0	12
31—45 „	- 2	1	3
Over 45	- 3	0	3
Total	- 28	2	30

## TROPICAL ULCERS



Fig. 38

Early Case—Non-traumatic origin.



Fig. 39



Fig. 40



Fig. 41



**Occupation:** Occupation does not seem to have any special significance.

Table VI.

Occupation				No.
Cooly	..	...	...	8
Student	...	...	...	4
Clerk	...	...	...	5
Nil	...	..	..	12
Peon	...	..	...	1
Total				30



Fig. 44



Fig. 42



Fig. 43



Fig. 45



Fig. 46

**Duration:—**

It varies from a week or ten days to weeks or even months. 14 out of 30 cases came with a duration of 1 to 6 weeks and 9 between 6 and 12 weeks.

Table VII.

Duration.	No.
Less than 1 week	2
1 to 3 weeks	7
3 to 6 weeks	7
6 to 12 weeks	9
More than 12 weeks	5
Total	30

**History:—**

The ulcer may start after an injury or abrasion. But many of them say that the trouble started with itching sensation and the formation of a pustule which bursts exuding serosanguinous fluid and leaving typical ulcer.

Of the 30 cases studied the number that gave a history of injury is 18. The rest gave no history of injury.

**Seasonal variation:—**

The incidence of these ulcers is great during and after the rainy season, when the roadside and garden are wet for some days together.

**General consideration:—**

It commonly manifests itself in the poor classes of people. Poverty, debility and unhygienic surroundings appear to play an important part.

**Description:—**

- Site:**
- (a) Over the region of the malleoli.
  - (b) Lower part of the leg—chiefly antero-medial surface of the leg.
  - (c) Toe — distal phalanx with the nail missing partly or wholly.
  - (d) Over the dorsum of the foot.

**Size:** Varies from the size of a pea to that of a rupee and even bigger in some cases.

**Shape:** Oval, nearly circular, or serpinginous. Irregular in some which are more than 1½" in diameter.

**Margins:** Clear-cut, regular, sometimes sloping. But on the whole the typical punched out appearance is noted in those over the malleoli and the shin of the leg. In a few of them the margins are undermined slightly.

**Floor:** Covered with a thick greyish yellow purulent slough. In these cases where the ulceration is still spreading it may be reddish brown or even show frank blood in streaks. The slough is loosely adherent and foul-smelling. When

the slough is removed pale; unhealthy granulation tissue which readily bleeds is seen.

- Depth:** Ulcer is quite deep and reaches the deep fascia or even bone which may be exposed in some cases.
- Base:** Is indurated. Not fixed to the surrounding structures.
- Discharge:** Serosanguinous in early days. Purulent and foul smelling later on with a characteristic odour.
- Pain:** Is very severe and the patient spends sleepless nights. Any movement in the inferior extremity gives rise to unbearable pain.
- Regional Glands:** Are almost invariably involved. They show an enlargement with tenderness and warmth over the region

in the early part of the course.

**General Reaction:** During the first week patient shows a febrile reaction with mild toxæmia.

**Causative Organisms** are the bacillus fusiformis and spirochaetæ of the Vincent type. Superficial layers of slough contain only the *B. fusiformis*. The deeper layers and the margins of the ulcer at the junction of the floor show spirochaetæ. During treatment, the spirochaetæ disappear first. Of the 30 cases all except two showed both the organisms. The spirochaetæ were not seen in the two cases. Some of the cases showed other infective organisms also—strepto, staphylo and gram negative cocci.

When the ulcer was washed with sterile saline, and the serous discharge as it oozed from its margins and the floor was sucked by a capillary tube and examined by dark ground illumination, spirochaetæ actively motile and in large numbers were revealed (3 cases). A smear of it with gram's stain revealed the bacillus fusiformis also.



Fig. 47

Perforating Ulcers-Leprotic.



Fig. 48

Gummatous Ulcers.

(For Differentiation.)

Smears taken from the tissue fluid sucked by a syringe and a needle from the ulcer margin passing through intact surrounding tissue did not reveal L.D. bodies (2 cases).

Attempts have been made to culture these organisms by a special Technique. With great difficulty one culture could be made out of five cases attempted. Sub-cultures are very difficult to obtain due to other saprophytic organisms predominating and killing the Vincent's organisms.

#### BIOPSY:

Biopsy from the ulcer margin shows the fusiform bacillus and the spirochæma Vincenti in the early cases only. Biopsy was done on four cases. In two the report read, "Chronic granulation tissue." In one the fusiform bacillus-only was seen in the subcutaneous tissue. In the fourth both the organisms were seen.

#### EXAMINATION OF BLOOD:

(1) Blood showed leucocytosis. It is very high in the early part of the disease and is about 10,000 per cmm. of blood during the later stages. In the early stages there is polymorphonuclear predominance and in the later stages relative lymphocytosis up to 40 per cent.

(2) Usually there is anæmia of hypochromic microcytic type.

(3) Blood wasserman reaction is invariably negative. Out of 25 cases whose blood was examined 24 were negative. One was positive strong. But his smears showed on D.G. examination Vincent's spirochaetae and the fusiform bacilli.

#### TREATMENT:

Various methods of treatment are in vogue. The general principle is to remove the sloughs from the base and give a protective dressing. I have tried the following methods advocated by James with slight modification:—

A liquid is prepared in the following proportion:—

Copper sulphate	... 1 oz.
Glycerine	... 2 oz.
Acid carbolie	... 1 dr. to an ounce of the resulting solution.

The ulcer is gently cleared with wool swabs, the limb placed horizontally and the solution is applied in a piece of wool of the size of a pea, the application being continued for about two or three minutes. Then a dressing of acriflavine 1 in 10,000 on gauze is applied. This is repeated once daily. Most ulcers were clean by the fourth or fifth day. Later 1% acriflavine ointment to protect the granulation and scarlet red ointment for the edges of the ulcer were given. The limb was strapped with sticking plaster and dressings repeated once in three or four days. The average duration for a case to heal is 6 to 8 weeks.

Table VIII.

Cases treated on James's Method:—

S. No.	No. of days in which organisms disappeared.	Wound healed in No. of days.
1	3	16
2	3	11
3	3	6
4	3	6
5	..	40*
6	..	20*
7	7	60*
8	2	5
9	3	...
10	2	4

\*Extensive ulceration — more than 2" in diameter. In one the subjacent periosteum was involved.

Some cases were dressed with 1% aqueous solution of Gentian Violet after the sloughs were removed and the results were equally good.

When the ulcer is small and not more than 1" in diameter it epithelialises well; otherwise, skin grafting has to be done after the sloughs are removed and the ulcer gets clear with the appearance of healthy granulation tissue.

When the ulcer is over a bony surface the scar that follows is very weak and may lead to secondary breakdown with the least trauma. So whole thickness skin graft in these situations has been advocated.

Cibazol powder by itself is effective in controlling the infection. However, it does not so

effectively and so quickly remove the slough as copper sulphate. Cibazol is not at all painful whereas copper sulphate caused much discomfort during and for nearly half an hour after the cleansing of the ulcer. The total time for the ulcer to heal is more or less the same in both the cases.

### PENICILLIN:

Penicillin has been tried only on a limited number of cases. It is instilled locally in 1 in 2,000 dilution. The slough is removed gently and mechanically and then the drug applied once a day. The pain disappears within half of an hour dramatically. The patient spends a very restful night after the first instillation itself. However the pain reappears the next day. But in three or four days it disappears once for all. The smears get clear of the organisms in 3 to 5 days. The wound rapidly epithelialises. The time taken to heal is very short—being only 8—18 days. The total dosage also does not exceed 10,000 to 15,000 units.

If penicillin can be made available in sufficiently large quantities for use in the outpatient department it can reduce the number of chronic cases that come for dressing day in and day out, and also, incidentally, the consumption of gauze and cotton used for dressings.

### (b) FUNGUS INFECTIONS

The infections usually start in the webs of the toes or in the edges of the nails. The first clinical symptom is itching especially when the lesions are moist. After the itching a small vesicle is formed. In most cases it gets inflamed and becomes a pustule containing a yellow fluid. When these vesicles are scraped and the fluid examined microscopically the fungus can easily be identified. Sometimes as a result of infection lymphangitis may develop. This causes denudation of superficial epithelium with spreading edges and several vesicles are found round one vesicle or they may spread in a line or circularly. The treatment of this is dressing with one per cent. aqueous Gentian Violet. These conditions are sometimes so resistant to any type of treatment adopted that only deep X-ray gives satisfactory results.

"Miss G. A. H.F. 16 years, admitted for the treatment of painful condition of the 3, 4, 5 toes. Patient developed a small vesicle on the inner aspect of the fifth toe of the left foot, three days before admission. It was painful, with itchy feeling all round. Then a number of them appeared one after another on the same surface of the fifth toe, on the abutting surface of the 4th and on the inner aspect of the foot. The outer aspect of the dorsum of the foot and the fourth and fifth toes showed swelling and lymphatic oedema. The popliteal and the inguinal glands were enlarged, painful and tender. The general condition was fair. Temperature 99° F. and P. 92 per min.

The vesicles were touched with 1% aqueous gentian violet, ichthyol in glycerine painted over the dorsum of the foot and streptocide given gm. 1 thrice daily for three days. The swelling came down, and the vesicles disappeared. She was all right in 15 days.

The various cracks and fissures noted in the foot around the margins of the heel and the sole are one type of manifestation of ringworm. This is met with in almost 60 to 80 per cent. of the working class of people. The fissure once formed is difficult to close up and heal as repeated pressure on the sole during locomotion opens their mouths. Due to the bare condition of the feet and the contact with moisture in the working class the possibility of secondary infection is very great. Infection thus superimposed may be localised or may spread causing severe reaction.

The treatment of these cases is continued rest, protection from moisture and application of fungicides like Whitfield ointment.

Ringworm infection may involve the nail which becomes discoloured and brittle. The nail should be trimmed and fungicides applied.

The other important variety of fungus infection of the foot is Mycetoma Maduræ.

### (c) MYCETOMA MADURÆ

This is a chronic inflammatory disease of the foot caused by a fungus of the Maduromyces-group. The foot gets swollen with pro-

gressive degeneration of the deep structures. The surface of the skin shows granulomatous nodules and the whole foot is riddled with sinuses. Those sinuses lead down to the diseased tissues in the depths of the foot. From the sinuses exudes an oily discharge containing small rounded granules. These granules are of different colours, black, white, yellow or red, one variety being present in one case.

The fungus can be demonstrated on squeezing the granules on to a microscope slide and examining it under the microscope. The mycelium will be seen as a fine net work with numerous branches, with radiating threads ending in prominent club shaped terminations like a ray fish; hence the name ray fungus.

The fungus gains entrance into the deeper tissues through a thorn prick or a scratch in the sole of the foot. The early lesion is a localised nodule of dense fibrous tissue containing the grains of the fungus. From this encapsuled nodule sinuses radiate burrowing into the tissues. Some may reach the surface on the dorsum of the foot or in the sole with nodular elevations with fine tracks within. As they burrow deep they do not respect muscle tendon, or bone, and disorganise and destroy all tissues. These sinuses may communicate with one another. The inflammatory reaction leads to fibrous tissue formation around the sinus tracts.

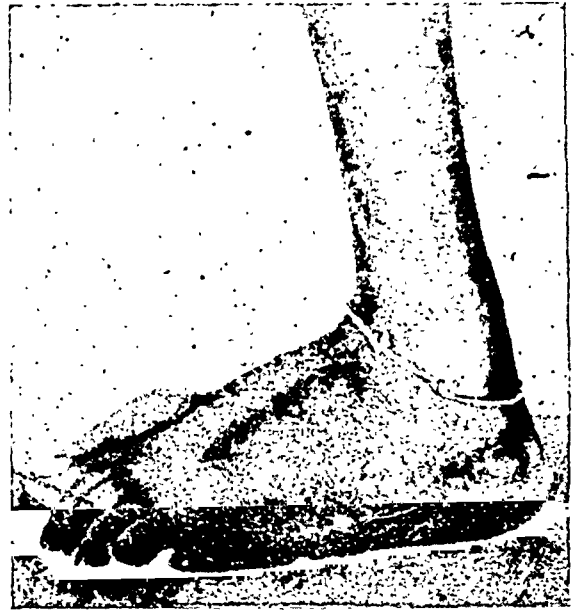


Fig. 50

Madurae Foot.



Fig. 49

Madurae Foot.



Fig. 51

Madurae Foot.

Regional lymphadenitis in the groin is common. Secondary septic infections may occur, but the disease does not often kill directly; eventually, the patient dies of some inter-current infection. The progress is very slow.

**Treatment:** In the early stages complete excision of the involved tissue with a diathermy knife is sufficient. But as is generally seen the cases never come to the hospital before the bones are also invaded; and at this stage amputation is the only recourse left.

"V.S. 40 years H.M. Ryot admitted for the treatment of a swelling of the left foot. The trouble started three years earlier as a small ulcer in the left foot just below the lateral malleolus; swelling followed and gradually reached the present condition, involving the outer and upper portions of the foot. Patient said that through the many openings on the surface of the foot sago grain like structures pass out in the 'pus'.

Examination revealed diffuse swelling of the left foot, both borders and the dorsum. The sole also was involved in the proximal half. Characteristic tubercles with sinuses at the summit of each, exuding seropus mixed with sago grain like bodies were present all over the swelling. The toes and the ankle region were free. Swelling was slightly warm to touch and hard to feel. Ankle movements free. Mid-tarsal movements painful and restricted. The general condition of the patient was good.

One of the granules from the wound was crushed on a microscope slide and stained and examined. *Actinomyces madurae* was identified.

An X-ray of the foot revealed circular areas of rarefaction and obliteration of joint space with decalcification suggestive of actinomycotic changes in the left tarsal and metatarsal regions."

**Treatment:** Amputation at the seat of election was done under spinal anaesthesia. Patient made an uneventful recovery

The pathological report on the specimen sent after amputation was 'section shows mycetoma *madurae*.'

#### (d) CORNS AND CALLOSITIES

Corns develop on the foot as a result of prolonged pressure—generally from ill-fitting shoes. They are usually found over the dorsum of the toes, and at the base of the metatarsals of the great and little toes. They are acutely painful and recur if not excised completely down to the core exposing the blood vessel at the root. Change of shoe to one with a broad toe only gives temporary relief.

Callosities form on the under-surface of the heel and the plantar aspect of the foot over the head of the first metatarsal. They are very painful. Effective cure is diathermy excision of the callosity. Relief can be obtained by taking the weight off the painful area by cutting in the sole of the shoe or the sandal conforming to the shape of the callosity.

#### (e) INFECTED BURSAE & CYSTS

The bursae that develop in the foot are always adventitious. Their development is always due to repeated trauma incident to the particular occupation. Bursae may develop over the head of the first metatarsal in hallux valgus (bunion) or over the tarsus in club foot.

**Traumatic bursitis:** Usually results from excessive friction and pressure. Serous fluid soon distends the bursa. Very severe pain will be present. But the process is generally chronic in this variety of bursitis. The synovial lining membrane gradually gets thickened with collection of serous fluid inside. If this continues without subsidence or repeats itself, the bursa becomes very thick with formation of adhesions inside.

**Acute Infective Bursitis** frequently follows abrasions and wounds. It may be a secondary feature in cellulitis and lymphangitis.

**Treatment:** If the infection does not subside completely and the condition causes continued pain and disability the entire bursa is dissected out and enucleated. If the symptoms are acute and there is effusion inside the bursa it should be incised to relieve tension. When the symptoms subside and infection is controlled the bursa should be removed entirely.

#### Infected cysts:

There were two cases admitted with a cystic swelling in the dorsum of the foot antero inferior to the tip of the lateral



Fig. 52



Fig. 53

#### INFECTED CYSTS

malleolus. One was of two months' and the other six months' duration. Both cases were painful causing discomfort.

They were enucleated entire. The pathological report on one of them was 'sebaceous cyst.' The other was reported on as a cyst containing hyaline material with no evidence of inflammation.

#### (f) INGROWING TOE NAIL.

Ingrowing toe nail is not a rare condition. It is seen only in the great toe more frequently at the medial edge of the nail. It may involve both the nail borders and may also be bilateral. This condition may be produced by a congenital malformation but is finally determined by faulty trimming of the affected nail in persons who habitually wear narrow shoes. Even though a large majority of our people do not wear shoes it occurs in a fairly good number of them. Faulty trimming of the nail leads to a possibility of dirt getting in between it and the epionychium, facilitated by their walking barefooted on the road side. This may lead on to ulceration or paronychia or even onychia



Fig. 54

Ingrowing Toe Nail





Fig. 55

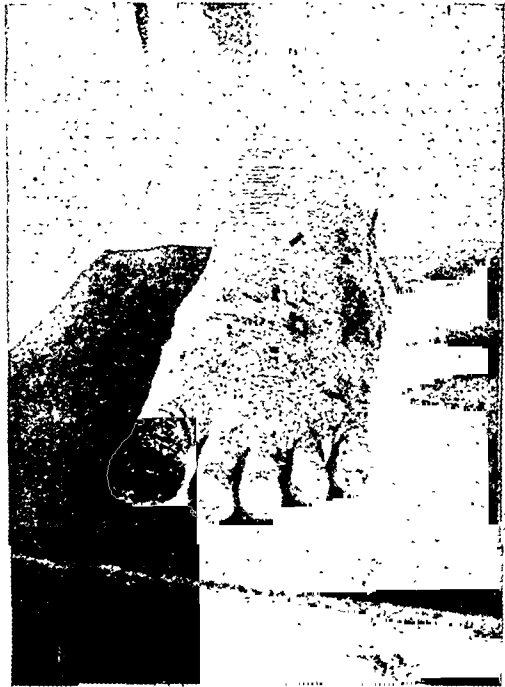


Fig. 56

Guinea-worm Cellulitis.

Fig. 57  
(Before Treatment)

CHRONIC INFECTION SECOND TOE,

with subsequent loss of the nail. Often the infection may become chronic and lead on to osteomyelitis of the ungual phalanx.

Treatment consists of excising the margin of the nail with its bed—or removal of the whole nail if both the edges of it are involved.

#### (g) ARTHRITIS:

Arthritis may be acute or chronic. Acute arthritis may be secondary to some systemic infection, the infective organism circulating in the blood and settling down in one of the joints; the ankle joint is rarely involved.

Chronic arthritis is usually tubercular in nature. The mid-tarsal joint is the one usually involved. It is mostly secondary to extension from chronic tubercular tenosynovitis of the tendons in the neighbourhood. The cases come usually late after the disease manifests itself and elective amputation becomes necessary.

#### (h) AINHUM.

This is a disease of the tropics affecting the fifth toe. A groove forms at the digitoplantar fold and deepens until the toe finally drops off.

Nothing is determined as to the aetiology. There is endarteritis with proliferation of the epidermis. The condition passes off unnoticed till the groove of separation begins to ulcerate. When pain develops it is of severe intensity. As the groove of separation deepens the terminal portion gets rounded, cold and hard. With the development of pain treatment is to snip off the toe and shorten the process of prolonged painful separation. The wound heals rapidly.

(i) **Guinea worm disease:** Guinea worm infection is endemic in many parts of India. After infesting the human body, the adult female worm works its way through the subcutaneous tissues and brings out its head through that part of the skin that is in constant contact with moisture usually the dorsum of the foot. The emergence of the head is made possible by local necrosis of tissue caused by

a helminthic poison. At this time the patient may complain of vasomotor disturbances as giddiness and vomiting. Septic infection of the necrotic tissue is very common resulting in cellulitis and abscesses. If the worm dies in the tissues it undergoes calcification giving rise to late sequelae.

**Treatment:** Removal of the worm by daily traction. Surgical excision is ideal. The entire length of the worm with or without the tissue-bed can be easily removed. Cellulitis has to be treated on general lines.

### SUMMARY.

1. An anatomical and experimental study has been made of the fascial spaces and tendon sheaths of the foot; the methods of study have been indicated and the findings described in detail.
2. The common infections of the foot occurring in South India have been discussed in some detail; the aetiological factors have been considered and the importance of the habit of walking bare-foot in the causation of these infection has been stressed. The treatment of each condition is indicated and clinical notes of illustrative cases appended.



Fig. 58

(After Treatment)

CHRONIC INFECTION SECOND TOE



Fig. 59

Osteomyelitis Great Toe.

## REPORTS OF CASES

## 1. ACUTE SPREADING INFECTION OF THE LEFT FOOT WITH SEVERE GENERAL REACTION:

(Treated with Penicillin).

K, 34 years, H.M., admitted for painful swelling of the left foot and leg. History of a thorn prick in the heel two weeks before admission. The thorn was removed and later the patient developed a painful swelling round the site of the original prick. The wound was explored by a local doctor, with no relief. The patient came to us with high fever, toxæmia and severe painful swelling of the foot and the leg.

Under general anaesthesia an incision and a counter incision were made over the margins of the heel and drainage instituted. No pus was struck. This did not improve his general condition. Thinking that drainage was imperfect the incisions were enlarged. This time also pus was not struck. The patient was put on cibazol (3 grms. per day) and Soluseptacine 5 cc 10% solution intra-

venously once a day. For a week the patient was on this treatment by which time he had 21 gms. of cibazol by mouth and 3 gms. of Soluseptacine intravenously. The temperature and pulse rate were still high and the general condition had not improved.

Blood sent for culture was returned negative for infective organisms. A swab from the wound on culture grew staphylococci. The patient was started on penicillin by the intramuscular route in 15,000 units a dose once in 3 hours. The temperature came down by the third day after the penicillin was started and it remained normal from that day. The patient had a total of 480,000 units of penicillin. The local condition also rapidly improved and the patient was discharged 12 days after starting penicillin and 19 days after the date of admission.

This case which was sulpha resistant reacted very well to penicillin.

## (2) GAS GANGRENE FOOT (RIGHT)

B. 25 years, H.M. Fisherman. History of gunshot injury to the right fore foot, 48 hours

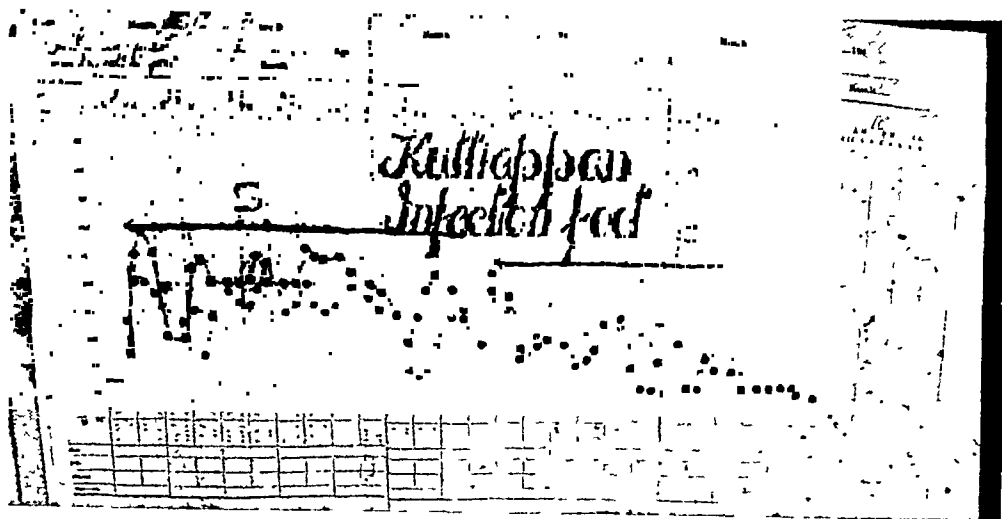


Fig. 60

Case I. Temperature and Pulse Chart of Case I.

Dark Spots—Temperature.

Light ones—Pulse.

Period for she was on Sulpha Drugs.

" " Penicillin.

before admission. The whole of the fore foot was shattered, dark and brownish in colour with loss of sensation distal to the base of the metatarsals, and evidences of gas formation. He had fever with rigour on the night before admission. General condition was fair and the patient was slightly toxic.

X-ray of the foot no bony structure visualised anterior to the talus.

Bacteriological report on the smears sent read "spore bearing bacilli seen in the smears."

Immediately on admission A.G.G. serum 4,000 units and A.T. serum 2,000 units were given. Operation under general anaesthesia "—commencing gas gangrene. At first partial removal was thought of. But later a modified Chopart's amputation was done. The wound was freely plastered with streptocide and closed in layers with two side drains." General condition attended to with glucose saline and plenty of fluids. On the third day the drainage tubes were removed.

On the 8th day the sutures were removed and limb put in plaster.

The wound healed well and patient was discharged two months later. He has been regularly observed at frequent intervals for the last three years. He has now a stable stump and goes about his fishing as usual with absolutely no disadvantage. Fig. 59.

The graft has taken fairly well and the patient is still under observation.

### (3) WEB INFECTION FOOT

G. H.M. 50 years. Admitted for pain and swelling of the left foot. The patient gives a history of injury to the left little toe due to stepping on sharp pointed charcoal two weeks before the date of admission. It bled a little and according to him the wound healed in three or four days. Ten days ago, he found swelling of the foot with pain in the little toe. The swelling in the foot has increased since then. Now the whole foot is throbbing with pain. He complains of pain in the groin also.

The general condition of the patient is good. The left foot was swollen, being mark-

ed in the dorsal aspect. The swelling looks tense and slightly pits on pressure; tender all over. There is a fluctuant area, in the region of the web between the fourth and fifth toes; the skin over the region is white and sodden. Regional inguinal glands enlarged and tender.

A diagnosis of web infection and abscess formation was made and the abscess incised and drained. On the third day, the drainage tube was removed. The swelling in the dorsum of the foot has come down completely. The wound was regularly dressed with streptocide. It healed in 10 days and the patient was discharged cured.

A smear of the pus showed staphylococci.

### 7. CHRONIC INFECTION SECOND TOE (RIGHT).

C.V. H.M. 11 years. Admitted for the treatment of an ulcer on the right second toe.

History of illness:—While going to school patient stubbed his toe on a stone and injured it. The wound did not heal and began to spread. There was severe pain leading to sleeplessness. General condition on admission was good.

Local condition:—A big ulcer over the terminal portion of the second toe right foot. The whole of the distal portion of the toe is swollen. Shape circular. Margins of the ulcer were sloping. Floor covered with ash grey pus; very pale granulation tissue. Base indurated and slight bluish appearance of the skin around. Movements at the metatarso-phalangeal joint are free. No appreciable inter-phalangeal movements due to swelling. Remnants of the nail with its proximal attachment visible. Regional glands not enlarged.

Urine acidic:—Albumin and sugar nil.

Blood:—W.R. negative.

X-ray:—Shows rarefaction of the terminal phalanx.

Bacteriological report:—Smear from the ulcer—a gram negative bacillus and borrelia (spirochaete) resembling Vincent's Organisms seen.

Pathological Report:—Biopsy—chronic inflammatory granulation tissue.

The wound was dressed with streptocide every day for a fortnight but it showed no improvement. So partial amputation of the toe removing the diaphysis of the terminal phalanx was done under general anaesthesia. Wound etherised freely plastered with streptocide and sutured with a drain.

The stitches were removed on the 7th day. The wound did not heal well and still showed the same organisms in the smear.

From the 10th day the wound was daily dressed with copper sulphate 1 in 200 solution. In 10 days the organisms disappeared from the wound. The wound was dressed with streptocide later and was healed in another 15 days.

This was one of the early cases in which infection with bacillus fusiformis and Vincent's spirochaete were encountered. Hence James' method of treatment was not tried and the progress was slow.

## OSTEOMYELITES OF THE GREAT TOE (LEFT).

### IN A DIABETIC.

S. H.M., 49 years. Sanitary Inspector, was admitted for the treatment of a discharging wound in the left foot in September, 1943.

**Previous History:**—Diabetic. In 1937 had the left index finger disarticulated at the metacarpo-phalangeal joint. Linear scars showing evidences of infection of fore arm and dorsum of the hand present.

In 1941—carbuncles—a crop of them all operated on,—mainly over the back, on arms and either leg also. Was in hospital for over a month.

During October, 1942, 11 months back, developed acute pain in the left great toe while cycling and had to abandon the vehicle at once. The following morning he noticed two openings one on either side of the nail in the margins of the great toe. They were exuding thin pus. 10 days later, the openings enlarged and communicated with each other across the anterior margins of the great toe distal to the distal margin of the nail. 2 or 3 small bits of bone were removed from this wound in a local hospital and the wound healed in about two months. He had no more

pain and he was able to cycle and discharge his normal duties.

**History of present illness:**—2 months and 15 days back he noticed a small opening in the medial margin of the great toe exuding thin fluid. He was dressing it with spirit gauze and going on his duty as usual. Since one month there has been pain and swelling of the foot. Swelling had involved the leg also since 20 days. Unable to cycle or even walk. He said that his urine was free from sugar, when last examined earlier than October, 1942. He examined it again one month back and found that sugar was present in plenty.

**Condition on admission:**—Elderly individual about 50 years of age—teeth—a few missing, remaining teeth dirty, tartar coated. No pyorrhoea alveolaris. Tongue moist, clean. No fever. Pulse 86 per minute; good volume and tension. Brachials show evidences of arteriosclerosis. Cardiovascular and respiratory systems—nil abnormal.

### Local condition:—

1. The whole of the left leg below the knee and the dorsum of the foot and also the balls of the great and second toes in the sole were swollen. Swelling in the dorsum was more marked along the medial border, extending beyond and behind the medial malleolus. Great toe was swollen to twice the size of the sound one and had a sodden appearance.

2. One big ulcer  $1\frac{1}{2}$ " x 1" over the dorsum of the foot at the proximity of the web between great and second toes. Pale granulation tissue. Bluish discoloration around the margins of the ulcer. Slight oozing of serous fluid. This ulcer is of 10 days' duration and is slowly spreading.

3. Another chronic indolent ulcer on the inner margin of the great toe discharging seropus.

4. The nail of the great toe is all shrivelled up, thin and soft.

5. Distally a groove showing the healed cross connection between the ulcer on the medial margin of the great toe and one which now is healed and located previously on the outer margin of the toe.

6. An ovoid ulcer with sprouting granulation tissue in three places distal to the ulcer men-

tioned under 3. On probing small bits of bone felt underneath.

7. Another small opening covered by a scab—distal and inferior to the one described previously under 6.

8. Inflammatory swelling of the medial margin of the foot involving the adjoining dorsal part of the foot, oedematous and tender on pressure. Swelling is spreading below and behind the medial malleolus.

9. Another small area, ovoid  $\frac{3}{4}$ " x  $\frac{1}{2}$ " over the dorsum of the foot in the lateral margin at the site of the base of the fifth metatarsal. Painful, tender on pressure. Soft no pitting on pressure.

10. Loss of sensation to pin prick below the level of the malleoli on the dorsum of the foot, along the lateral border and to about 1" anterior to the lower border of the medial malleolus on the medial aspect of the foot.

Loss of sensation to touch—cotton wool—below a level of  $\frac{3}{4}$ " above the tips of the malleoli—over the dorsum of the foot and in the borders.

Regional glands — Popliteal and Groin glands are enlarged and tender.

Urine—Reaction acidic. Sugar 3%. Albumin Nil.

Blood—Wasserman negative.

Blood pressure 125/65.

Glucose tolerance test:—

Blood sugar. Fasting 320 mgm. per cent.

$\frac{1}{2}$  hr. after giving 50 gm. of glucose 380 mgm. per cent.

1 hr. after giving 50 gm. of glucose 500 mgm. per cent.

$1\frac{1}{2}$  hr. after giving 50 gm. of glucose 532 mgm. per cent.

2 hrs. after giving 50 gm. of glucose 532 mgm. per cent.

Urine sugar in all specimens.

X-ray revealed necrosis with partial absorption of the bones of the left great toe. All the phalanges involved.

Bacteriological report:—Smear from the sinus on great toe shows streptococci, staphylococci and pus cells.

Treatment:—Eusol baths and dressing. Insulin to control diabetes.

Advised amputation of the great toe. Patient refused operation and was discharged against medical advice.

## 9. ACUTE LYMPHANGITIS.

Miss L. 24 years. Admitted for a painful condition of the foot with an ulcer between the toes. On the night before admission, the patient felt itching sensation in the web between the fourth and the fifth toes of the left foot. She scratched and an ulcer developed over that area with pain shooting all over the foot. She was unable to walk and movements of the foot caused pain at the seat of the ulcer.

The general condition of the patient was good. There was a small ulcer in the web between the fourth and fifth toes with slight swelling all round. The whole area around was red, inflamed, painful and very tender. Red streaks of lymphatics could be seen running up the dorsum of the foot in front of the ankle up to the lower  $\frac{1}{3}$ rd of the leg starting from the site of the ulcer. A smear from the ulcer showed streptococci.

The ulcer was dressed with streptocide. Ichthyol in glycerine was painted over the dorsum of the foot. The ankle and the foot were strapped. Streptocide 1 gm. three times a day was given by mouth for two days. On the third day, the pain came down, the streaks disappeared and the patient was able to go about normally.

## 10. ACUTE LYMPHANGITIS LEFT LEG WITH ABSCESS FORMATION.

P. H.F. 25 years, was admitted for the treatment of painful swelling of the left leg and foot, 20 days' duration. There was no history of injury. The dorsum of the foot and the leg swelled up suddenly with severe pain all over and inability to walk. This subsided in about 8 days, though not completely. 13 days later, the pain and swelling reappeared with inability to walk. This time also she did not give any history of injury.

On admission, the patient was acutely ill, actually in agony with pain. The temperature was 98.8° F. Pulse 98 per min. of moderate volume and tension. Slight evidences of toxæmia present. Examination revealed swelling of the dorsum of the left foot and the lower

two-thirds of the leg. The skin was shining and dark brick red in colour, warm to touch, acutely tender and severely painful. No red lines made out in the leg, due to the dark complexion. Movements of the ankle and midtarsal joints possible though painful. The popliteal and groin glands were palpable, warm and tender.

The limb was freely painted with ichthyol in glycerine, and bandaged. The patient was started on streptocide 3 gms. a day. There was intermittent rise in temperature reaching up to a maximum of 102.4° F. in the evenings. On the fourth day after admission, the patient developed an abscess at the junction of the lower and the middle thirds of the leg. It was incised and drained. On the sixth day, the temperature came down and remained normal afterwards. The swelling of the leg and the dorsum of the foot almost disappeared. The skin was showing wrinkles. On the 12th day, the patient was perfectly normal with no pain or swelling in the foot or leg. She was able to walk slowly. The abscess wound was almost healing. By the 18th day the wound was healed and she was discharged. A smear from the pus showed staphylo and streptococci.

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# INTESTINAL ANTHRAX

## Report of a Case

BY

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The rarity of anthrax infection of the human intestine is well established (Topley & Wilson, 1937; Jordon & Burroughs, 1945; Muir, 1941). Very few cases are reported in the literature. But intestinal anthrax involving the colon resulting in peritonitis is so extremely rare that the following case is of special interest.

### REPORT OF CASE.

On March 30, 1946, S, a girl at 10 years, was admitted into the Children's ward of the King George Hospital, Vizagapatam with breathlessness and distension of abdomen of four days' duration. No history of any infection could be elicited from the patient or her relatives. The girl was quite healthy previous to this illness. Four days prior to her admission into the hospital, she complained of pain in the left hypochondrium, and soon after watery diarrhoea commenced. There was no vomiting at any time. No blood had been noticed in any of the motions. Bowels were moving 6-10 times a day. Abdominal pain was not of a very severe nature. Gradually the abdomen became more and more distended, increasing breathlessness supervened and the child became more and more ill. There was a low grade fever throughout. On admission, the patient was acutely ill, pulseless and very dyspnoeic with a respiratory rate of about 40-50 per minute. Signs of toxæmia were very marked. She had clammy extremities, intense thirst and pinched facies. She passed a watery motion after admission. On physical examination, the abdomen was distended and there were signs of free fluid. No rigidity was felt in any place, but there was slight tender-

ness with a feeling of a vague mass on deep palpation in the left hypochondrium. The spleen and liver were not palpable. Nothing abnormal could be made out in the heart and lungs except for an extremely rapid heart rate. The tongue was dry and slightly coated. The total W.B.C. count was 18,000 per c.m.m. with 84% polymorphs, 12% lymphocytes, 2% eosinophils and 2% monocytes. The abdomen was tapped and a pint of thin purulent fluid was withdrawn. Gram's staining of the pus showed Gram-positive organisms which resembled *B. anthracis*. Fluid was taken for culture and other investigations. Examination of the motion showed nothing abnormal. The history and clinical findings, which were not typical of any surgical or medical condition, were rather puzzling. The surgeons were of opinion that the condition might be a subacute peritonitis; but any surgical interference was ruled out owing to the gravity of the patient's general condition. There was no constipation, no vomiting, nor rigidity of the abdominal wall, though the patient was having septic peritonitis.

After tapping the fluid, the child was relieved to some extent and was more quiet. 40,000 units of penicillin was put into the peritoneal cavity through the tapping canula and oral sulphonamides were started along with intravenous glucose-saline drip; but the condition became rapidly worse and the patient died at about 7 p.m. on the same day.

Bacteriological investigations of the material on plate cultures on agar and blood agar showed pure typical Medusa-head colonies of the anthrax bacillus. Fluid cultures in glucose



and Hartley broth showed deposits of the fluffy small cotton-wool type. The organisms were long, non-motile, Gram-positive strepto-bacilli indistinguishable from *B. anthracis*. Intramuscular inoculation into a guinea-pig of 0.5 c.c. of a 24-hour culture of Hartley broth produced death in 48 hours. Anthrax bacilli were found distributed in all the organs and were also present in the heart blood removed at autopsy.

At autopsy (3rd March, 1946), the body was fairly nourished, but the abdomen was distended. There were six ounces of foul smelling, slightly blood stained, turbid fluid in the peritoneal cavity. The intestinal lesion was an irregular area in the descending colon at its junction with the sigmoid, extending all round the lumen, 7 c.m. in length and 1 c.m. in thickness (Fig. I). The wall was raised above the surface. The mucosal folds were very much exaggerated and rounded. There were brownish areas of diffuse submucous hæmorrhages with scattered superficial areas of yellowish slough, varying in size from a pea to

a pin's head. The serous coat showed much more œdema and extensive submucous hæmorrhage, and small areas of opacity due to adherent lymph. The surrounding mucous membrane was not affected and the whole lesion was localised to a small segment of intestine. Glands appeared to be slightly enlarged. Purulent material was adherent to the surface of the mucous membrane over the affected patch. The appearance was quite unlike the superficial serpiginous ulceration and surface necrosis that is found in bacillary dysentery. The spleen (142 g.) was slightly enlarged and perisplenitis was present. Fatty degeneration of the liver (256 g.) was noted. Pleural cavities contained 12 ounces of blood stained fluid. The base of the right lung (198 g.) was congested. The left lung (198 g.) showed extreme congestion and areas of collapse and emphysema. The Brain (1250 g.) was congested. Uterus and tubes were normal. Smears from the intestinal ulcer, spleen and heart blood showed typical, capsulated, Gram-positive bacilli resembling *B. anthracis*.

Histologically, sections of intestine, spleen and liver were stained by hæmatoxylin and

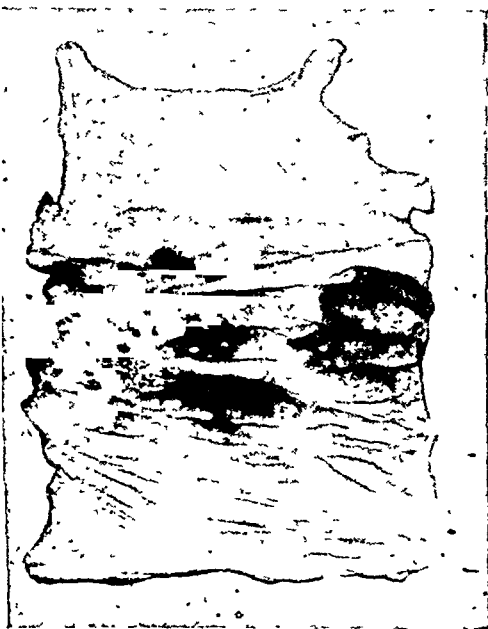


Fig. I

A large hæmorrhagic oedematous area in the wall of the colon showing small superficial specks of necrosis.

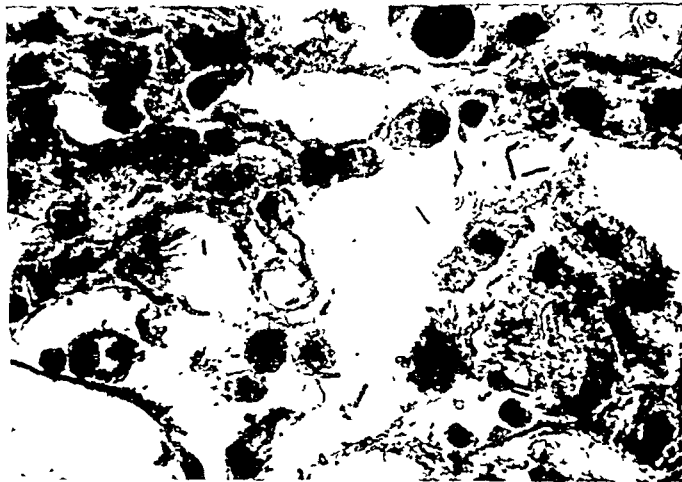


Fig. II

Photomicrograph showing the anthrax bacilli scattered in the inflammatory exudate in the peritoneal coat. MacCallum's modification of Goodpasture's method. ( $\times 700$ ).

eosin and by MacCallum's modification of Goodpasture's method for the demonstration of Gram-positive and Gram-negative bacteria. The section of intestine showed ulceration and necrosis of mucosa. The anthrax bacilli, which were stained blue by the modified Goodpasture's method, were found in large numbers throughout all the coats, but were prominently seen in the sero-muscular coat (Fig. II). A characteristic of the animal lesion is that the bacilli remain confined almost entirely to the blood vessels and are found in maximum numbers in the capillaries of spleen, intestine, liver, etc. and their distribution varies with the animal attacked (Topley & Wilson, 1937). In the present case, however, the lumina of blood vessels were comparatively free. It is possible that the patient might have died before the organisms had proliferated sufficiently to be detected microscopically. This feature has been observed by Stockman (1911) in his studies on pigs and horses. Sections of spleen showed the organisms distributed in large numbers in the pulp, while the sections of liver showed only a few.

The anatomical diagnosis was:—(1) purulent peritonitis due to anthrax infection with 6 ozs. of blood stained, turbid, foul-smelling fluid in the peritoneal cavity; (2) an oedematous haemorrhagic lesion involving the wall of the descending colon, with darkish and haemorrhagic mucosa showing pale yellowish necrotic patches; (3) 12 ounces of blood stained fluid in the pleural cavities; and (4) slight enlargement of the spleen. Death was regarded as due to peritonitis from leakage through the circumscribed intestinal lesion.

#### COMMENT.

The alimentary tract, although the usual route of infection in cattle, is very rarely that in man. A few instances are on record of intestinal anthrax contracted through the medium of spore-infected food. These cases occur among workers with animal material and have probably been due to lack of caution and handling of food with unclean hands. Insufficiently cooked meat from anthrax-infected animals may also be a source of intestinal anthrax. The bacilli are destroyed by the gastric juice, but the spores escape and multiply in the intestine. Experimental evidence, based on the findings in laboratory animals, suggest that for this mode of infection

to occur in man, large numbers of spores must be present in food (Topley & Wilson, 1937). M'Fadyean (1903) has observed that animals dying or just dead may contain the bacilli in their milk; chances of infection by this method is also possible.

It does not seem necessary that all who partake of infected food should suffer from the disease. Senai (1933) reports that in a population of a camp of Kossacks, who ate vea from a calf killed while it was sick with anthrax only one of the participants contracted the disease. By precipitation tests conducted on the members of the tribe, he has shown that consumption of meat infected with *B. anthracis* may also lead to an asymptomatic form of infection. In the present case it could not be elicited whether the patient had taken improperly cooked infected meat or unboiled milk from an infected animal or whether any other members, who partook of the same food contracted the disease. Enquiries through the public health authorities for contacting the parents of the deceased in a village in the Vizagapatam District, have not borne fruit. It is interesting to note that, while the site of infection is usually in the upper part of the small intestine with one or more focal lesions, in the present case it is in the descending colon. The characteristic clinical feature of bloody diarrhoea was not met with. A curious feature in this case was that the bacilli had invaded the serous coat and the peritonium through the necrotic mucous membrane of the colon.

#### SUMMARY.

A case of intestinal anthrax occurring in a young girl of 10 years, causing peritonitis, is described and the pathogenicity of *B. anthracis* for man is discussed.

Our thanks are due to Prof. T. Bhaskara Menon, M.D., D.Sc., F.R.C.P. (Lond.), Major S. Shone, M.D., M.R.C.P., I.M.S., and Prof. N. G. Pandalai, M.D., D.T.M., F.R.C.P. (Edin.) for their kind help in placing the material at our disposal.

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## FOREIGN BODIES IN THE STOMACH

BY

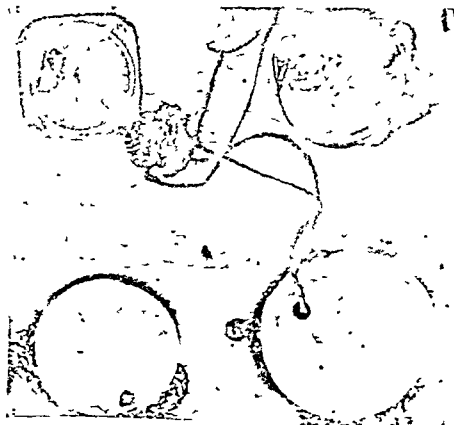
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It has been enunciated as a general rule that foreign bodies which pass through the gullet usually pass through the pyloric sphincter of the stomach and also through other sphincters of the intestinal tract. A variety of foreign bodies in the stomach have been reported in the literature, such as pins, tin tags, tooth plates, coins and hair balls.

The following 4 cases illustrate the types of foreign bodies swallowed. Of these one was a composite mass of lead held together by a string and two were rupee coins and one was a quarter of an anna swallowed accidentally. This last case is reported to show the contrast of the progress of the coins through the pyloric sphincter when compared with those of rupee coins and is not of any academic interest. But the previous three are of sufficient academic interest deserving a report in a journal.

1. In 1936, a male, aged 45 years, a prisoner in a jail was trying to develop a monkey pouch in the cheek by constantly keeping weighty material on one side of the cheek to enable him to hide contraband material. He prepared a discoid type of lead piece along with two two-anna lead pieces to serve as a weight to develop the pouch in the cheek. One day, he accidentally swallowed this weigh and



1. Photograph of the lead pieces removed. They were held together by a piece of string. The pieces were separated and mounted on a plaster of paris slab.

never informed anybody. It passed through the oesophagus without causing any trouble and remained lodged in the stomach. He gradually began to develop colic and jaundice and was admitted into the hospital for this complaint. On clinical examination a diagnosis of obstructive type of jaundice due to gall stones in the common bile duct was made. On X-ray

examination a dense discoid shadow in the pyloric region was seen. At first it was thought to be some metal pieces held outside the body and so a second X-ray examination was made after carefully stripping the patient. The same shadow persisted in the X-rays a second time. So a diagnosis of a foreign body in the stomach was made. On questioning the prisoner he admitted having swallowed the lead pieces by accident. A gastrotomy was done and the foreign bodies which were held together by a piece of string (Fig. 1) were removed. These metal pieces were very heavy, being pieces of lead, of which one was of the

size of a rupee, the other of the size of an eight anna silver piece and the third were two anna lead pieces and were counterfeit coins. By sheer weight in the region of the pyloric canal they must have obstructed the common bile ducts as it passed behind the first part of the Duodenum to gain entrance into the second part of the Duodenum. How far the lead by absorption has been responsible for the production of jaundice is difficult to say. There was, however, evidence to show that the gastric juice had acted on the lead. He made an uneventful recovery and follow up could not be done. Unfortunately his X-ray showing the foreign body is lost, but the foreign body removed has been preserved mounted on a plaster slab in the museum.

2

2. Radiographic picture showing the rupee coin as it lay in the pyloric antrum of the stomach.



4. Radiographic picture showing the quarter of an anna as it lay in the lower portion of the rectum above the last Houston's Valve.

3

3. Radiographic picture taken after giving barium meal. Note the dense circular shadow covered by Barium.

2. In 1937, a male was admitted into the hospital for having swallowed a rupee coin by accident—a rupee which he held between the teeth accidentally slipped into his Pharynx and he swallowed it. On X-ray examination, it was found that the rupee coin had got lodged in the pyloric antrum but failed to pass through the pyloric sphincter. As it did not pass through the sphincter even after waiting for two days and as the patient was complaining of pain in the region of the stomach, he was operated on. A gastrotomy was done. An attempt was made to force the coin through the pyloric canal and sphincter but it was found

difficult to do so without damaging the mucous membrane of the sphincter. The rupee was removed and the gastrotomy opening was closed and the patient made an uneventful recovery. On follow up he states that he is keeping very good health (Figs. 2 and 3.).

3. In 1941, a male, aged 35 years, was admitted with a similar history as in the second case. Similar investigations were made, X-rays were taken and the coin was found in the identical position. At operation, similar findings were noted. The patient made an uneventful recovery. On follow up he is found to be in good health.

4. In 1942, a male aged 8 years with a history of having swallowed a quarter anna, was brought. The metal piece not having come out with faecal matter, the mother got anxious and brought the patient to the hospital. Screen, examination showed the position of the coin above the last Houston's valve of the

rectum; it was manually removed after taking an X-ray. This case shows that the quarter anna piece easily passes through the pyloric sphincter and is reported to show the harmless consequences of swallowing a quarter of an anna.

#### POINTS OF INTEREST:—

- (1) These 4 cases are reported to illustrate the types of foreign bodies seen in the gastro-intestinal tract.
- (2) The heavy lead pieces caused obstructive symptoms of the common bile duct by sheer weight and caused obstructive type of jaundice.
- (3) The rupee coins in both the cases could not pass through the pyloric sphincter.
- (4) The last case is reported to show by contrast, the easy passage of a quarter anna coin, through the gastro intestinal tract.

## A CASE OF OSTEOCLASTOMA OF THE HEAD OF FIBULA

BY

DR. S. P. SRINIVASTAVA,, M.S., F.R.C.S. (Eng.), AGRA.

O.C., age 35 years, male, was admitted on 1-3-1946 with a painful swelling in the upper third of right leg. Duration:—about one year.

**History:—**The swelling was small in size at first but for the last three or four months has been growing rapidly. It was painful; otherwise there was no discomfort or any disability. The patient was a healthy young man with no history of loss of weight. On examination, the swelling was limited to the upper third of right leg on its outer aspect just below the level of the knee joint. Size of the swelling was about 4" x 3", hard in consistency at places specially in the centre and soft at the periphery. Its outline was diffuse merging into the surrounding tissues. The swelling was tender and slightly hot to touch. There were one or two prominent veins on the surface beneath the skin.

Palpation showed that the swelling was in the head and upper third of the shaft of the fibula.

The knee joint was free and all its movements were normal and painless. The movements of the ankle joint were also normal and there were no signs of involvement of the common peroneal nerve. X-Ray of the swelling showed expansion and destruction of the head and upper third of the shaft of the fibula.

**Operation Notes:—**Operation was done under spinal anaesthesia 10 c.c. of Percain 1 in 1,500 being used.

A vertical incision about 6" long was made on the outer side of the upper third of the leg and the skin flaps reflected. The common peroneal nerve was isolated. The tumour tissue had infiltrated the bellies of the extensor and peroneal groups of muscles in their upper thirds and so they had to be divided at the level of the division of the shaft of fibula. There was slight infiltration of the growth into the bony portion of the lateral condyle of the upper end of the Tibia and the capsule, and during the process of excision, the knee joint was

exposed at one place. The peculiarity of the growth was that it was completely avascular and the excision was altogether bloodless. The wound was closed with a drainage tube kept for 24 hours. The lower limb was kept on a posterior plaster slab with the foot at the right

diagnosis of Osteoclastoma starting in the head of fibula and involving the upper third of shaft. In the skiagram the upper end of the Tibia appeared to be free but exploration showed that this was also involved.

The tumour had extended beyond the confines of the bony wall and invaded the muscles which had, therefore, to be excised.



Skiagram showing expansion and destruction of the head and upper third of the Shaft of the Fibula.

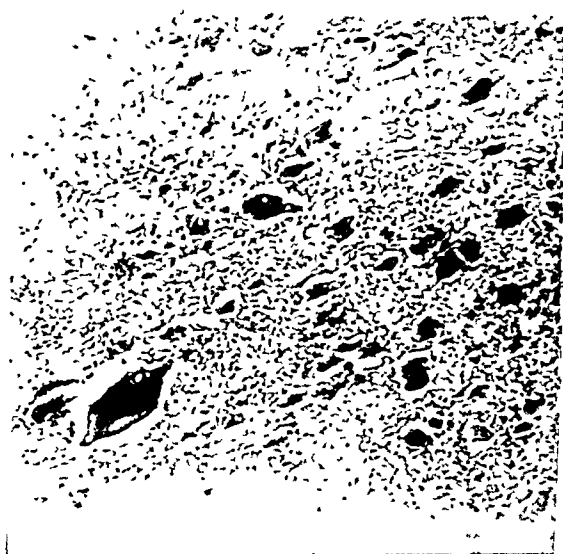
angles to the leg. Healing was by first intention without any limitation of movements of the knee joint. There was foot drop perhaps due to the division of the muscles in their upper third as the nerve trunk was definitely saved except for the division of a few twigs coming in the way.

The patient was given a plaster boot with walking caliper for about 6 weeks as he would not stay in the hospital for faradic massage of muscles or post-operative deep X-Ray therapy.

After removal of the plaster, there was not much improvement in the paralysed muscles. otherwise the patient was perfectly alright without any pain in the leg.

**Pathological report:**—Picture suggestive of Osteoclastoma.

**Discussion:**—The history, clinical picture and skiagram leave us in doubt regarding the



Photomicrograph of section from the tumour.

The knee joint was not involved, the infiltration occurring only up to the articular cartilage of the upper end of the Tibia. Had the patient been operated on earlier, excision of the head alone would have been sufficient for complete cure, but the prognosis now is guarded.

The avascularity of the growth is a significant feature here, very much like the white myeloma, described in the lower end of the radius and unlike the usual picture seen in Osteoclastoma occurring elsewhere. There was complete absence of the bony shell around the growth. The latter was friable and brownish in colour.

I am thankful to Maj.-General H. C. Buckley, I.M.S., Superintendent, for allowing me to publish the case, and to Dr. H. N. Bhatt, F.R.C.S. (Edin.), D.M.R.E., for the skiagram. I am also thankful to Dr. B. N. Wahi, Professor of Pathology for the photomicrograph.

# FACILITIES FOR INDIAN RESEARCH WORKERS IN ENGLAND

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The following has been sent by the Surgeon-General with the Government of Madras, to the Secretary, Association of Surgeons of India, for circulation among its members:—

Copy of D.O. No. 19-2-46-P, & D from the Director-General, Indian Medical Service to Surgeon-General with the Govt. of Madras.

Sub: Facilities for Indian Research Workers in England.

The Indian Research Liaison Committee in London has undertaken to offer advice regarding the laboratories and institutes in the United Kingdom in which facilities for special training in research may be obtained by Indian Medical Graduates and to assist, as far as possible, in placing such workers in suitable institutions.

The Committee considers that, as at present the number of admissions available in the United Kingdom is very limited, full advantage can be taken by India of such admissions only *if applications from this country* are submitted *through a special channel* and if approximate steps are taken to ensure that persons with high academic qualifications and a background of experience giving promise of high performance after training, are alone selected and sent to that country.

The overseas training scheme which has been sponsored by the Government of India in association with Provincial Governments will, it is considered, help to secure that most of the places available in the United Kingdom for training research workers will be reserved for candidates who are selected by the Central Selection Board appointed by the Government of India and, therefore, the Committee's suggestion will, to a great extent, be met. It is at the same time probable that a certain number of medical candidates for studies abroad will attempt to secure admission in the United Kingdom by direct approach in that country. We have been informed that those authorities are particularly anxious that the record of such applicants should be evaluated and that a definite opinion about their suitability should be given by a competent authority in this country. While the Indian Research Liaison Committee has naturally raised the question only about those desiring training in research institutions in the United Kingdom, instances are not frequent of candidates for other types of post-graduate training in medical subjects proceeding from this country to Britain without having secured admission beforehand and of their finding themselves in difficulty after arrival there. In order to minimise the occurrence of such cases I am asked by General Hay to say that he would be grateful if adequate publicity could be given in your province, through medical associations, recognised service associations and medical colleges to the facts set out about and if all intending candidates could be encouraged to apply through your office and not directly to the institutions concerned in the United Kingdom. Such applications, if they are sent with your recommendations to this office will be fully considered and all available steps will be taken to secure, as far as possible, admission for deserving candidates in suitable institutions.

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# THE INDIAN JOURNAL OF SURGERY

Vol. X

MARCH 1948

No. 1

## "TUMOURS OF THE SPINAL CORD"

by DR. N. S. NARASIMHAN, F.R.C.S., *Surgeon, Govt. General Hospital, Madras.*

To Gowers and Horsley must be assigned the credit for the birth of spinal cord surgery. In 1887 they correctly diagnosed and removed a primary spinal cord growth and also analysed the records of 58 cases of which only one had been submitted to surgery. Since that day spinal cord tumours being daily more frequently recognised and removed, so that the mortality in cases treated surgically has decreased considerably. In the hands of Elsberg it has reached 2% in his last 100 cases.

Nevertheless one feels that several cases of spinal tumours remain undiagnosed or only recognised when they have reached a late stage. It is often possible in a busy out-patient department to dismiss a case with, for example, root pain, as neuralgia and several cases of early spinal tumour have been mistaken for acute appendicitis (Kinier Wilson)? During examination of a large number of cases of backache, sciatic pain and brachial neuralgia seen in the Orthopaedic out-patients by the writer the possibility of a tumour of the cord has been kept in mind. Three cases of extensive neurorofibroma of the trunk were investigated because they complained of indefinite radiating pain but a spinal block could be demonstrated only in one case.

The following seven cases of spinal cord tumour are being presented with a view to illustrate the difficult points in diagnosis. Two of these cases were at first misdiagnosed though the symptoms were not atypical. These cases were seen in the period between December 1943 and December, 1947.

## CASE REPORTS

### Case 1.

P., Gownder, male, 35 years, was admitted into the medical wards complaining of inability to walk for the past three months, pain in the back and incontinence of faeces. He was referred to the Surgical side as a case of tuberculous disease of the spine.

The patient gave a history that a year ago he had fallen from a height of ten feet but, except for a little tenderness over the small of the back which lasted for four days, he had no other symptoms. Six months ago he noticed severe stabbing pain in the back which increased at night, but which did not prevent him from doing his work. He then gradually noticed that his legs were becoming weaker so that he had an unsteady gait. With the onset of unsteadiness he also lost control of his bladder and rectum.

On examination it was found that he had complete paraplegia. Inspection of the spine revealed a marked posterior curvature in the dorso-lumbar region with a slight lateral curvature to the right. The dorso-lumbar region was tender. This tenderness was most marked over the 11th and 12th D.V. There was no spasm of the spinal muscles. Motor power of the upper extremities was normal, but was lost in the lower limbs which were equally wasted. Sensation was completely lost below the level of the middle of the thighs and there was a saddle-shaped area of anaesthesia. The tendon jerks were absent in both lower extremities and the cremaster reflex could not be elicited. Abdominal reflexes were present on the right side. The anal sphincter was lax and the patient had precipitancy of micturition. X-ray revealed no bony disease even on careful re-examination although at operation and subsequently at the autopsy the laminae and the posterior aspects of the bodies of the vertebrae were seen to be eroded.

Lumbar puncture showed that the C.S.F. was clear, was not under pressure and the Queckenstedt test was negative.

Cistern puncture revealed that the C.S.F. was normal.

Proteins — 30 mgms.

Globulin — nil.

Sugar — 57.5.

Chlorides — 740 mgms.

Wassermann Reaction — Negative.

2 c.c. of lipiodol injected into the cistern was completely held up at the level of the body of the 5th dorsal vertebra and had not leaked downwards after 24 hours.

Laminectomy was undertaken under intra-tracheal  $C_2E_1$  after premedication with 3 drms. of paraldehyde per rectum. The laminae of the 8th, 9th, 10th and 11th dorsal vertebrae were removed. The left lamina of the 9th dorsal was found eroded and the dura was bulging through the space. On opening the dura a gelatinous looking tumour about one inch in diameter involving the posterior surface of the cord for about 5 inches from the 8th segment was visible; below this obstruction, the cord was not pulsating. As the tumour was extensive and was thought to be intramedullary only a portion of it was removed.

The patient recovered from the initial shock but showed no general improvement. There was no relief of any symptoms. The operation wound healed by first intention but the patient deteriorated in health and died one month after operation of bed sores and cystitis. The Pathologists' report on the piece of tumour tissue was 'Neuro-fibroma.'

On partial post-mortem of the spine it was found that the laminae were eroded to a length of five inches. There was erosion of the posterior surfaces of the bodies of the corresponding dorsal vertebrae. The spinal canal was increased to more than three times its normal size. The cord and nerve roots could not be identified separately and the growth had extended through the intervertebral foramina which were increased in size. Histological examination of several sections of the autopsy material showed the same neuro-fibromatous structure. The spinal cord could not be taken out for preservation.

## Case 2.

Ramaswami, aged 25 years, a weaver by occupation was admitted on 12-11-45 for inability to use the lower limbs and neuralgic pain in the chest for the last 8 months. On questioning he gave no history of injury. He stated that all of a sudden, he had noticed severe pricking pain on the right side of the chest at the level of the nipple. The pain was initially confined to the right 5th intercostal space but gradually spread round the chest during a period of two months. This constant pain disturbed the patient's sleep and occupation. He then noticed numbness gradually spreading over both lower limbs from toes to groins, and there

was occasional tingling. Within a fortnight he had difficulty in walking and within a month was unable to leave his bed. During a further period of a month he noticed that he was unable to bend his knees, but experienced occasional painful flexor spasms. For this pain and spasm he consulted a doctor and was given anti-syphilitic treatment (four injections) without relief. At the same time the patient lost bladder and rectal control and sought admission to hospital.

He was admitted into the venereal wards and it was found on examination that he had spastic paraplegia and loss of all sensation from 2 inches below the nipple downwards with a band of hyperaesthesia above this level. Both anal and bladder sphincters were incompetent, so that the patient had incontinence of urine and faeces. The laxity of the anal sphincter was evident on digital rectal examination.

On lumbar puncture the C.S.F. was not under pressure and, though Xanthochromic, did not clot. Bio-chemical examination revealed protein excess — 600 mgms. Globulin — and 13 cells (lymphocytes) per c.m.m. Both the blood and C.S.F. gave a negative Kahn reaction but the Wassermann was positive. An X-ray of the spine showed no evidence of bony disease. On the strength of the positive W.R. and the cells in the C.S.F. a diagnosis of spinal syphilis was made by the Venereologist and the patient given 20 injections of 20 c.c. of sod. iodide intravenously on alternate days from 24-11-45 and 7 intramuscular injections of 0.2 gm. of bismuth weekly. There was no relief of symptoms and a spinal tumour was suspected on account of failure of treatment and the marked radicular neuralgia.

To locate the site of the tumour, cistern puncture was done and 3 c.c. of lipiodol was put in; X-ray revealed the lipiodol to be held up at the 4th thoracic vertebral body in a cup-shaped form. The C.S.F. from the cistern was clear and contained 50 mgms. per cent proteins, globulin nil, chlorides 630 mgms. and a few R.B.Cs. Hence a diagnosis of intradural tumour at the level of the 4th thoracic vertebra was made. (In a patient with a spinal tumour and a positive Wassermann reaction comparison of protein values of cistern and lumbar puncture is of value.)

Under rectal ether in oil and local Novocaine (½% solution) infiltration, the laminae of the 2nd to 6th dorsal vertebrae were removed. The lipiodol put in was seen at the level of the 4th dorsal vertebra and the dura was pulsatile above the 2nd dorsal vertebra. On opening the dura a soft tumour, about one inch in vertical extent, was seen covering the anterior and posterior surfaces of the cord, adherent in places to the dura. The adhesions were easily separated and the tumour removed with little bleeding. The tumour appeared

extramedullary. Pathological examination of the tumour proved it to be a fibroblastoma. (Fig. 1.)

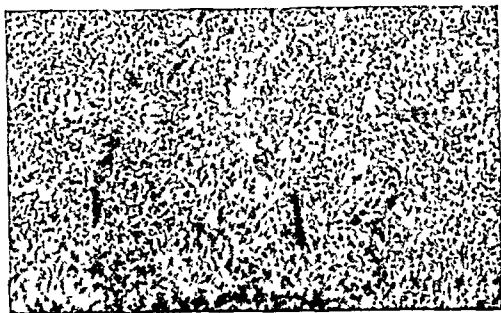


Fig. 1.

**Fibroblastoma:**—Low power photomicrograph showing the fibroblasts in irregular columns and cells with abundant cytoplasm and dark round or oval nuclei.

Ten days after operation the patient felt heaviness of both lower limbs, but the neuralgic pain round the chest had completely disappeared. For about a month he had not regained control of his bladder or rectum but could feel when the bladder was full. Flexor spasms had disappeared. Two months after operation he could flex and extend his knees. Touch, pin-prick and vibration sense were normal in both the lower limbs. Sense of position and passive movement was not accurate. Temperature sense:—Cold was not appreciated over the right leg and heat was inaccurately appreciated. Knee jerks were still exaggerated and the plantar response was extensor on both sides. Sphincter control was normal. He was able to get about with crutches.

### Case 3.

Venkatapathy, aged 29 years, came to hospital complaining of severe pain over the left hip and thigh confined more to the lateral aspect of the limb. This pain had started abruptly two years ago and had increased in intensity since then preventing him from pursuing his usual occupation. The pain was continuous, shooting and piercing in character, often made worse by bending, coughing or by movement of the spine. It was not paroxysmal, nor lightning in type. It was so constant that his sleep was disturbed and this made him seek medical advice. No history of injury could be elicited nor was there history or evidence of venereal disease.

The patient appeared fairly well nourished, his weight being 102 lbs. He had a mild kyphoscoliosis with a tilt towards the right and the glutei and hamstring muscles on the left appeared wasted. On examination there was slight tenderness over the lumbar spine and a mild degree of

spasm of the spinal muscles in that area. The movements of the spine were normal except lateral flexion which was painful. Both hip joints appeared healthy. To exclude early tuberculosis of spine or hip both areas were X-rayed, but no abnormality was found. The blood sedimentation rate was normal. The patient had a normal temperature and blood Wassermann and Kahn were negative. In spite of negative X-rays the left hip and lumbar spine were immobilised in a plaster spica as a therapeutic test. A fortnight's immobilisation only served to intensify the pain according to the statement of the patient who continually demanded morphia as no other analgesic relieved him. It now appeared likely that one was dealing with a tumour of the spinal cord, and a complete neurological examination was undertaken. There was wasting of the right gluteal muscles: sensation and reflexes normal.

A lumbar puncture was done. The C.S.F. was not under pressure, was tinged yellow, but there was no spontaneous coagulation. Biochemical examination revealed protein 100 mgm. Globulin + + chlorides 600 mgms. sugar 60 mgm. There were no cells. Lange's test was normal, and W.R. and Kahn were negative. These findings were suggestive of a sub-arachnoid block. With a neuralgic pain in the gluteal region and thigh, wasting of the gluteal muscles, the existence of a



Fig. 2.

Proteins — 30 mgms.

Globulin — nil.

Sugar — 57.5.

Chlorides — 740 mgms.

Wassermann Reaction — Negative.

2 c.c. of lipiodol injected into the cistern was completely held up at the level of the body of the 5th dorsal vertebra and had not leaked downwards after 24 hours.

Laminectomy was undertaken under intratracheal C.E.<sub>1</sub> after premedication with 3 drms. of paraldehyde per rectum. The laminae of the 8th, 9th, 10th and 11th dorsal vertebrae were removed. The left lamina of the 9th dorsal was found eroded and the dura was bulging through the space. On opening the dura a gelatinous looking tumour about one inch in diameter involving the posterior surface of the cord for about 5 inches from the 8th segment was visible; below this obstruction, the cord was not pulsating. As the tumour was extensive and was thought to be intramedullary only a portion of it was removed.

The patient recovered from the initial shock but showed no general improvement. There was no relief of any symptoms. The operation wound healed by first intention but the patient deteriorated in health and died one month after operation of bed sores and cystitis. The Pathologists' report on the piece of tumour tissue was 'Neuro-fibroma.'

On partial post-mortem of the spine it was found that the laminae were eroded to a length of five inches. There was erosion of the posterior surfaces of the bodies of the corresponding dorsal vertebrae. The spinal canal was increased to more than three times its normal size. The cord and nerve roots could not be identified separately and the growth had extended through the intervertebral foramina which were increased in size. Histological examination of several sections of the autopsy material showed the same neuro-fibromatous structure. The spinal cord could not be taken out for preservation.

## Case 2:

Ramaswami, aged 25 years, a weaver by occupation was admitted on 12-11-45 for inability to use the lower limbs and neuralgic pain in the chest for the last 8 months. On questioning he gave no history of injury. He stated that all of a sudden, he had noticed severe pricking pain on the right side of the chest at the level of the nipple. The pain was initially confined to the right 5th intercostal space but gradually spread round the chest during a period of two months. This constant pain disturbed the patient's sleep and occupation. He then noticed numbness gradually spreading over both lower limbs from toes to groins, and there

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To locate the site of the tumour, cistern puncture was done and 3 c.c. of lipiodol was put in; X-ray revealed the lipiodol to be held up at the 4th thoracic vertebral body in a cup-shaped form. The C.S.F. from the cistern was clear and contained 50 mgms. per cent proteins, globulin nil, chlorides 630 mgms. and a few R.B.Cs. Hence a diagnosis of intradural tumour at the level of the 4th thoracic vertebra was made. (In a patient with a spinal tumour and a positive Wassermann reaction comparison of protein values of cistern and lumbar puncture is of value.)

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a saddle shaped area covering both gluteal regions and the perineum and blunting of all sensations over the skin of the external genitals. Testicular sensation was normal. There was loss of all sensations below the tendo-achilis on both sides. Vibration sense was lost on the left side but present on the right.

**Gait:** Patient walked with support with a high stepping gait. Rombergism was present. Heel knee test and Finger nose test were normal.

Trophic ulcers were present over the upper part of natal cleft and the posterior aspect of the left heel.

**Laboratory findings:** Blood fbr Kahn—Negative. Spinal fluid—Queckenstedt's sign—Negative. Fluid was yellowish and not under pressure. Cells—3 per c.mm—all lymphocytes. Total protein—1500 mgms.%. Globulin ++++ W.R. 0.1 c.c. and 0.5 c.c.—doubtful. Lange's test—Negative.

Cistern puncture was done in the erect posture 1½ c.c. of lipiodol was put in. Skiagram of the spine after lipiodol was suggestive of adhesions and presented guttering in the region of the 8th, 9th, 10th and 11th dorsal vertebrae. No bony changes were noted in the spine.

Urine — Nil abnormal.

Blood picture — Nil abnormal.

Fractional test meal — Nil special.

**Electrical reactions of muscles:** The following changes were noted in the muscles of the lower limbs.

	Right.	Left.
Thigh ant. aspect.	Normal.	Normal.
„ post aspect.	„	„
Leg post. aspect.	Weak normal.	Weak normal.
„ ant. aspect.	P.R.D.	P.R.D.
Foot.	„	„

**Ophthalmoscopic examination:** Nil particular.

In view of the fact that the spinal fluid revealed Xanthochromia and increase of proteins compression of the cord was thought of. Lipiodol pictures of the vertebral column revealed the presence of 'guttering' which was highly suggestive of arachnoiditis. The anatomical site of the lesion was localised at the lumbo-sacral region because of the following reasons:

1. There was absence of cremasteric reflex.

2. Lipiodol guttering spots were present at the anatomical level of the 9th dorsal vertebra. (Fig. 4). Further the shadow of lipiodol was a straight line on the right side and irregular on the left and hence this pointed to the lesion being more on the left side.

3. The lower level of the adhesions had not been determined by lipiodol but clinically it seemed as though it involved the sacral segments

too, in view of the saddle shaped anaesthesia and anaesthesia over the tendo-achilis.



Fig. 4.

Lipiodol picture of Case 4.

The diagnosis of arachnoiditis was made and 5 million units of penicillin were given. It was found that a few signs and symptoms improved. Touch, temperature and pain sensibility were nearly normal as far as the knee on both sides. Saddle-shaped anaesthesia also improved. The left knee and ankle jerks exaggerated. Bilateral cremasteric reflex was absent. Since the essential features of compression persisted and cell count was only 3 (lymphocytes), it was strongly suggestive of a cord tumour and the patient was transferred from the venereal department. Again lumbar and cistern punctures were made. Lumbar puncture fluid was not under pressure. Xanthochromia was present. The specimen clotted in a few minutes. No cells were found. Proteins were 5 gms. of which globulin was 2 gms. Though the pressure of the fluid was not increased by pressing the jugulars, it flowed in jerks when he coughed, indicating that the block was not complete. Cistern puncture specimen was clear. Protein was 100 mgms.% and globulin was just present. It contained a few R.B.C. and W.B.C. With the above findings an exploration was decided upon.

After premedication with paraldehyde under gas and oxygen supplemented with local (1%) novocaine 80 c.c. an incision about 6 inches long was made on the middle of the back with the 10th dorsal spine as the midpoint. Posterior spinal

muscles were retraced. Four trephine holes were made and the laminae were removed. It was found that the cord did not pulsate from 8th d.v. downwards. Near the 10th dorsal vertebra a bony mass was found protruding towards the spinal cord. This was chipped off and just beneath it, a fleshy vascular tumour was found in connection with the spinal cord and duramater. On lifting up the mass, there was profuse haemorrhage. The tumour was the size of a cherry, situated on the lateral aspect at the level of the 10th dorsal vertebra encroaching on the anterior aspect of the cord; the posterior surface of the body was eroded. On inspecting the eroded portion of the vertebra, a cavity  $\frac{1}{2}$ " x  $\frac{1}{2}$ " x  $\frac{1}{2}$ " was left after removing a mass of soft white tissue continuous with the tumour mass. It was found that the cord was constricted and narrowed above the site of the tumour and at the site it was flatter and broader. As much of the tumour as could be removed was excised in bits and sent for pathological examination. Bleeding was controlled by muscle graft. Duramater in the region of the 9th d.v. was slit and lipoidal was let out and washed with 20 c.c. of normal saline. Even at the end of the operation the cord did not pulsate but no further cause for obstruction was noted. Operation was completed, with muscle and skin stitches. Plasma was administered during the latter part of the operation. Patient was nursed on his face.

*Path. report* was Neurofibroblastoma (Fig. 4a). He had flexor spasms on the left side and developed retention of urine. He had to be catheterised and was put on sulphathiazole tablets and penicillin 15,000 units every 3 hours. 2 days later he began to have control over the bladder.

Sutures were removed. The wound healed by first intention. Patient was put on his back. Gradually he was encouraged to sit and hand down his legs. The pain in the limbs improved day to day. His sensations of touch, pain and temperature were better appreciated all over both the limbs though still impaired. His knee jerks were normal. There was no ankle clonus or extensor planter response on the left side. He was given boots with lateral iron and was walking with crutches.

#### Case 5.

Mr. Venkatasubramaniam, Male, aged 42 years, was admitted for inability to use the lower limbs which were rigid in a flexed position with flexor spasms.

*History of illness:* In 1934 he had an attack of fever with dysentery for which he got treated. Following this he began to feel a burning sensation over the lateral aspect of the muscles of the right thigh with occasional twitchings of the muscles of the thigh. The burning sensation then spread to the right leg and twitching appeared in the leg also. Along with this he noticed dryness of the skin of the lower limbs with wasting of the mus-

cles. Slowly the same symptoms appeared in the left leg also. All the time he was able to perform his work. For 4 years he was taking various medicines. Then in 1938 he came to this hospital on the medical side and the following investigations were done. Lumbar puncture:—Cerebrospinal fluid was positive for Wassermann. Chlorides 745 mgm.



Fig. 4a.

Meningioma:—Polyhedral or spindle-shaped cells arranged concentrically about a central lumen; the endothelial characters of the cells are well seen.

%, protein 80 mgm. % globulin trace, no cells. The gold curve was Meningitic. Fluid was not under pressure. No colour changes. Blood Wassermann—negative. He was given N.A.B. and was asked to report but he had no relief. In 1939 he was treated for Ichthyosis by a different physician. In 1940, as the symptoms persisted as before and spasms increased in frequency and the gait was unsteady, he came to the hospital again and a diagnosis of disseminated sclerosis by another physician was made. In 1941 in another hospital, lumbar puncture was done. Proteins 120 mgm. % Globulin 58.2 mgm. %, Chlorides 690 mgm. %, Wassermann negative, cells 2 per cmm. He was treated with Nicotinic acid and vitamins. He had no relief, the muscle spasms extended up the abdominal walls, to the epigastrium. In 1943 he had to give up attending his office. He was not able to walk about in the house, weakness of the lower extremities increased and he had to stay in bed.

Then his lower limbs got flexed and he again got himself admitted on 27-10-46.

**Examination:** Cranial nerves were normal except for nystagmus. He had spastic paraplegia with limbs in flexion and abduction and constant flexor spasms. All the reflexes of the lower extremities were exaggerated with ankle clonus and extensor plantar response. There was loss of sensation of touch, pain and temperature on the lateral aspect of right thigh, leg and foot. Abdominal reflexes were lost. Epigastric reflex present. No sensory loss. Abdominal muscles were rigid. During sleep he had no control over micturition but at other times he had precipitancy. He was constipated but was able to control defaecation. The rest of the nervous system and other systems were normal. A diagnosis of cord tumour was made and a lumbar puncture done. Fluid was clear, not under pressure, very little in quantity, Queckenstedt's phenomenon was absent. A few cells were present.

A cistern puncture was done. CSF. was clear and not under pressure 2 c.c.-of lipiodol was put in and the Radiographs revealed a block at the level of the middle of the 4th dorsal vertebra with

localised to the 8th spinal segment from the rigidity of the muscles and the presence of the epigastric reflex. Lipiodol however showed arrest at the level of the 4th dorsal vertebra. (Fig. 5). It was decided to operate.

Under intratracheal gas and oxygen with local novocaine, laminectomy was done and the 2nd and the 7th dorsal laminae were removed. At the level of 5, 6, and 7th d.v. the dura was not pulsating. There was no extradural tumour. The dura was opened and lipiodol let out. A tumour 3" in length was found on the anterior aspect of the cord and extending into it. There was no capsule. The tumour was removed piecemeal. Pathological report was Glioma. (Fig. 6.)

During the post-operative period patient required catheterisation for a week. There was loss of sensation below the chest for three days. The number of flexor spasms were diminished. He passed urine by himself and had control over the



Fig. 5.

a smooth convex upper border. (Fig. 5)—Re-X-ray in 24 hours showed the same pattern with a little leak on the left side. As lipiodol was put in he complained of severe pain on the right side (arm). Clinically the upper level of the lesion could be

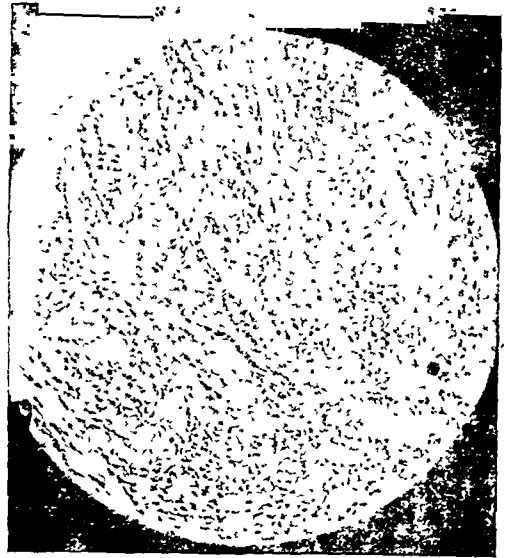


Fig. 6.

Glioma (Fibrillary astrocytoma):—Photomicrograph showing cells with scanty cytoplasm and deep staining nuclei; the fibrils in wavy parallels form an open network.

urinary sphincter but the anal sphincter was lax. Subsequently he developed bedsores over the sacrum and trochanteric regions; cystitis became severe; the paraplegia became flacid with oedema of legs. Temporary improvement resulted with sulphathiazole and Penicillin injections and blood transfusion. Nursing became very difficult. Gradually he lost ground and died. An autopsy was not available.

## Case 6.

Natesa Pillai, aged 50 years, was admitted on 10th December 1946 for pain in the chest since 5 months.

*History of the previous illness:* An excision of a neurofibroma which was situated on the right side of the back over the erector spinae was done in July 1946. That tumour was 3" by 3" and was of 8 months' duration.

*History of present illness:* A month after the excision of the neurofibroma he developed pain and burning sensation over the right side of the chest between the 3rd and 8th intercostal segments. The pain was almost constantly present.

On examination of the Nervous system all the cranial nerves were normal. There was slight impairment of the power of the muscles of the right upper extremity but the other limbs were normal. Gait was normal and no Rombergism was present.

*Reflexes—Superficial:* Abdominal reflexes were present in all quadrants. Cremasteric reflex was sluggish on both sides. Plantar reflex was extensor on the right side and normal on the left side.

*Deep:* Knee jerks were brisk on both sides and ankle jerk was weak on the left side. Jerks in the upper extremities were normal.

*Sensation:* Touch was lost between the 6th and 8th dorsal segments on the right side and there was hyperaesthesia at the 6th segment.

Sphincters were normal.

*Alimentary system:* Nil abnormal.

*Respiratory system:* Harsh breath sounds over the right apex. Feeble sounds over the left apex. Trachea was deviated to the right side.

*Cardio Vascular system:* Arteriosclerotic changes in the vessels were noted.

*Lumbar puncture:* C.S.F. was not under pressure and it was clear. Queckenstedt's phenomenon absent.

Proteins — 240 mgms. per 100 c.c.

Globulin — + +

Chlorides — 700 mgms. per 100 c.c.

Sugar — 63.2 mgms. per 100 c.c.

Wassermann — Negative.

Fundus showed arterio sclerotic changes; Disc was normal.

B.P. 160/105. Hb. 80%.

Urine — Nil abnormal.

A cistern puncture was done. Fluid was under normal pressure, slightly turbid and the Queckenstedt phenomenon was present. 2 c.c. of lipiodol was put in. The X-ray showed that there

was arrest at the level of the 5th thoracic vertebra.

Under intratracheal ether, gas and oxygen supplemented by local novocaine, incision was made from 2nd to 8th dorsal spines and laminae were removed by trephining and the space was widened by nibbling. Anterolaterally on the right side opposite to the 5th, 6th, 7th vertebral bodies, there was an extradural neurofibroma which had invaded the bone and vertebral foraminae. The tumour was traced through the vertebral foraminae into the chest and as much as possible was removed piecemeal. The 5th posterior root was also removed on the left side. Towards the end of the operation the right pleura got opened. There was an immediate fall in B.P. and the pulse became imperceptible; with the usual measures his condition improved and the operation was completed. 400 c.c. of whole blood was given from the beginning of operation, followed by glucose saline.

Patient died one hour after operation. Only a partial autopsy was available. Both the lungs were found collapsed. There was six oz. of blood-stained fluid in each pleural cavity; heart, lungs and bronchi were normal. There was a neurofibroma of the 5th, 6th and 7th intercostal nerves on the right side and the sympathetic chain was thick and fibromatous. 5th nerve on the left side was also affected. The dissected specimen and ribs are preserved in the Madras Medical College pathology museum (Figs. 7 & 8).

*Pathological report:* "Neurofibroma".

## Case 7.

F. A weaver, aged 35, was admitted on 30-9-'47 for inability to walk. When he came to the outpatient department he was seen to have severe extensor spasm of the muscles of the lower extremities.

*Previous history:* He gave a history of exposure to venereal disease 15 years ago. He said he had a white urethral discharge at that time, but was not quite definite about a sore on the penis.

*Family history:* Married, had five children, one died at the age of three years. No history of miscarriage by the wife; wife and the remaining children healthy.

*Present history:* The present complaint started two years back with gradual weakness and unsteadiness of one lower extremity. Ten days later he developed weakness and spasticity in the other and he was completely paralysed and unable to walk in a few months. Last year he went to Coimbatore Hospital for treatment where he was given 4 injections of N.A.B., five injections of bis-muth and one or two injections of T.A.B. Vaccine.

*General Condition:* Patient was a fairly well-nourished individual of 35 years, not anaemic;



both his lower extremities were paralysed and went into severe extensor and flexor spasms periodically. Bowels constipated. There was difficulty in micturition, which the patient used to overcome by periodical expression.

*Nervous system:* Speech, intelligence and memory good.

*Cranial nerves:* All normal.

Patient had a spastic paraplegia, with exaggeration of the deep reflexes. Ankle clonus present. Bilateral extensor plantar present. Oppenheim and Gordon reflexes could be elicited. Mass reflex phenomenon could be easily elicited on slight pressure over any part of the lower limb,

Globulin — ++

Blood Kahn — 0.1 and 0.5 c.c. negative.

Wassermann — Positive.

Urine — Nil abnormal.

X-ray spine — No bony lesion.

Injection of iodised oil into the subarachnoid space: Hold up of iodised oil at the level of T.I.

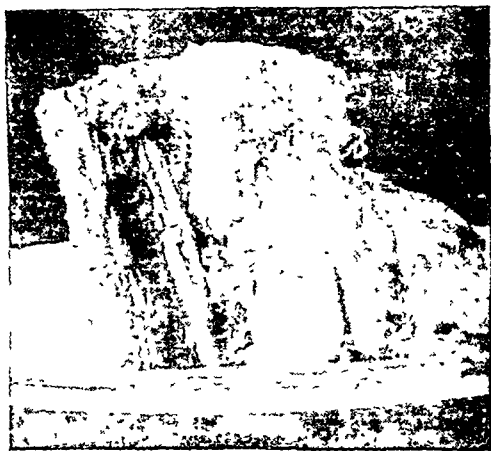


Fig. 7.

Specimen of Rib and Neurofibroma of the intercostal nerve

ie, dorsi-flexion of the ankle, flexion of the knee and thigh. Sometimes he went into severe flexor spasm on slight change of posture of limbs. Abdominal and cremasteric reflexes lost. Jerks in the upper extremity equal and normal.

*Sensation:* Light touch, temperature and pain lost completely below the level of the nipple. He also had a girdle sensation round about the nipple. This located the level of the lesion between 5th and 4th dorsal segments. Joint sense lost.

*Visceral reflexes:* There was no incontinence or retention of urine. He had difficulty in micturition. There was no incontinence of faeces.

*Investigations:* L.P. was done and yellow coloured fluid was drawn. Queckenstedt phenomenon absent. C.S.F. results:

Colour — Xanthochromia.

Proteins — 360 mgms.



Fig. 8.

Spinal Cord with Neurofibroma.

The iodised oil remained in the same position even after 24 hours. A radiograph taken a fortnight after injection of iodised oil showed it was still held up at the same level and showed the characteristic cupping deformity.

Under general anaesthesia (endo tracheal gas oxygen ether) with local infiltration with novocaine, a laminectomy was performed, the centre of the incision being the spine of 7th cervical vertebra. The spinous processes and laminae of 5, 6, 7, 8 C. and 1 and 2 D. were removed. A non-pulsatile plum coloured mass protruding through a dural defect towards the left was seen; the cord was pulsating above the mass; the protruding mass which was granulomatous in appearance, friable and continuous with the cord was removed; the anterior aspect of the cord was free. Patient had 320,000 units of Penicillin in three days after operation.

Retention of urine had to be managed in the post-operative period.

The histological report was "Fibroblastoma"; the tumour was highly vascular.

A week after operation the patient complained of pain below both knees, worse on the left leg; ankle and knee jerks normal; Babinski, more brisk on the right side. Tone of flexor muscles greater than extensor; flexor spasm more on the right side; sensation of touch and position impaired to the level of the nipples. An area of hyperaesthesia present on the left side from the level of the left nipple upto the level of the sternal angle, strictly unilateral. Three days later hyperaesthesia was present in the anterior axillary fold on left side and slight hyperaesthesia along ulnar border of left arm. Hyperaesthesia over area of T1 & T2 same as before. Cremasteric and abdominal reflexes absent on both sides. Babinski and pain in left leg present as before.

The flexor spasm became greater five days later in both lower extremities than on previous occasions; more in left leg. Knee jerk exaggerated on left side, brisk on right side. Pain and hyperaesthesia were the same. Patient was able to go about in a wheel chair.

A month after the operation the patient lying with legs semiflexed, unable to extend; burning sensation in both legs, light touch and pinprick appreciated above the epigastrium on both sides; Babinski, knee jerks and ankle clonus were positive.

To this series of true cord tumours, a case of hypertrophy of ligamentum subflava producing symptoms and the notes of two cases of compression syndrome where a laminectomy did not reveal a cord tumour are also added below:

#### Case 8.

Male, aged 24 years, resident of Cuddapah dist., admitted on 22-6-1946.

His complaint was shooting pain on the right side along the course of the sciatic nerve and burning sensation over the right thigh since last three months. Pain increased on walking or standing for a long time. Since one month he noticed burning pain also on the left thigh.

On examination, he was a well nourished individual. The positive findings were exaggeration of the left knee jerk and pain on stretching the right sciatic nerve. He had tenderness over the spines of the 4th and 5th lumbar vertebrae.

Rectal examination — Nil abnormal.

Urine — Nil abnormal.

Blood — W.R. and Kahn — Negative.

X-ray lumbar spine — Nil abnormal.

On 25th June L.P. was done. Initial pressure was low. 20 mm. Quickenstedts phenomenon present.

C.S.F. Total Protein — 30 mgms. per 100 c.c.

Globulin — Nil.

Chlorides — 720 mgms. per 100 c.c.

Sugar — 43.29 mgms./100 c.c.

Cell count — 1 lymphocyte.

W.R. — .1 c.c. .5 c.c. negative.

On 30th June 20 c.c. of novocaine was infiltrated into the right sacro-iliac region for relief of pain. Patient was not appreciably benefitted.

On 4th July cistern puncture was done. Fluid was not under pressure and was clear. Total protein was 40 mgms/100 c.c. and no globulin was present. Lipiodol was injected and was found to descend to the level of the 1st sacral vertebra without obstruction. A clinical diagnosis of hypertrophied ligamentum flava was made and on 9th July under spinal anaesthesia a linear incision was made and the spinous processes and laminae of L1, 2, 3 and 4 removed. The dura was cut and the spinal cord was inspected. No evidence of any tumour or abnormality of any nerve was noticeable. Wound was closed in layers.

The patient was discharged with complete relief of all the symptoms. This patient has been seen several times and is free from pain.

The absence of a pathological lesion in the cord and the relief following laminectomy suggest the ligament as the probable cause of the compression. This could have been demonstrated with proper technique of lipiodol myelography but was not done.

#### Case 9.

V., Patient, aged 23 years, resident of Madras, admitted on 28-1-47 for difficulty in walking and loss of control over micturition since last ten months.

He gave a history of a fall from 25 feet height, a year ago. He was not unconscious. After three months he noticed sudden retention of urine. Gradually he developed imperfect control of urinary sphincter. He had also developed burning sensation as well as pins and needles over lower half of abdomen and lower extremities. Further he had occasional tremors of hands and irregularity in the bowels.

On examination of the nervous system the cranial nerves were normal. Motor power was impaired in all the four limbs. Co-ordination was normal.

*Jerks*: Knee and ankle jerks on both sides were exaggerated. Upper limb jerks were normal. Ankle and knee clonus were present. There was bilateral extensor plantar response. Cremasteric

reflex was absent on both sides. Abdominal-reflex was absent in lower quadrants.

**Sensation:** Light touch was impaired below both ankles. Heat and cold was not appreciated over the whole of the left leg. Pin-prick was absent below the left knee. Vibration sense was lost up to the iliac crest on the left side. Joint sense was normal.

No zone of hyperaesthesia was present. Clinically the lesion was suspected to be at the 10th dorsal segment of the spinal cord.

Urine — Nil abnormal.

B.P. 90/65 Hb. 60%

**X-ray spine:** Lumbar and sacral region — Nil abnormal.

On 30th January Lumbar puncture done. Fluid clear, not under pressure. Queckenstedt's test showed an initial quick rise to 35 cm. and a gradual fall to normal (15 cm.) within just over 2 minutes.

#### *Bio-chemical tests:*

Proteins — 20 mgms.

Chlorides — 720 mgms.

Sugar — 57.8 mgms.

Globulin present.

Cell count — 30 cells.

**Blood** — Wassermann and Kahn — Strong positive.

The Venereologist advised antisyphilitic treatment, with sodium iodide and bismuth.

A second lumbar puncture done. The fluid slightly under pressure.

Total proteins — 60 mgms.

Chlorides — 680 mgms.

Sugar — 60 mgms.

Globulin present.

Total cell count — 40 cells per c.mm.

Gold curve — 0.1 c.c. precipitated.

0.5 c.c. precipitated.

55111,00000.

The antisyphilitic treatment was completed but the patient did not improve. The fractional test-meal and B.M.R. estimation were normal.

A cistern puncture was done and 2 c.c. of lipiodol put in. A myelogram was taken.

Cistern puncture C.S.F. showed Proteins — 10 mgms. %. Globulin — Nil. Cells — Nil.

The Myelogram showed that the lipiodol was held up at 6th and 7th dorsal level. Therefore a diagnosis of spinal cord tumour at the level of the 7th dorsal segment was made.

Under intra-tracheal anaesthesia supplemented by 100 c.c. of 1% Novocaine, a longitudinal mid-

line incision from the 5th dorsal vertebra to 10th dorsal was made. Laminectomy of 6th, 7th, 8th and 9th thoracic vertebrae was done. During the operation a considerable amount of bleeding from the bones on the left side was noted. The spinal cord was found to be pulsating well. No bulging, cedema or thickening of the cord or dura was noticeable. The dura was opened and C.S.F. flow was free. The lipiodol was removed. There was no evidence of arachnoiditis. The anterior aspect of the spinal cord was inspected. No abnormality was noticed. Anterior surface of the dura also showed no abnormality. Wound was closed in layers.

In the post-operative period, patient developed retention of urine and was being catheterized 6th hourly followed subsequently by incontinence. Bed-sores over right great trochanter and right knee and ankle developed. He was unable to lift up both the lower extremities and developed paraplegia in extension. Patient was given one megaunit of Penicillin.

The patient later was able to sit up but not walk without support. Bed sores gradually healed. He had loss of sensation to touch and pin-prick over left lower extremity right up to the iliac rest. Bilateral extensor plantar response persisted. Urinary and rectal sphincter control was normal.

The patient has subsequently improved in general health but his cord symptoms have remained the same. This is probably a case of a vascular disorder of the spinal cord in a Syphilitic patient. He had received three megaunits of Penicillin which was given as the radiograph showed lipiodol in streaks in the lumbar region. Lumbar puncture and manometry shows normal pressure of C.S.F. with correct response on jugular vein pressure and C.S.F. normal with no protein and with negative reactions of Khan and W.R.

#### **Case 10.**

K., aged 25 years, was admitted in the surgical wards on 6-5-47.

**History of the previous illness:** The patient gave a history of a sore on the penis six months ago. He had a fall 10 months ago. For the first 4 days after the fall he was unable to pass urine or motion. He was treated in Trichy for retention of urine and a suprapubic catheter was inserted. The patient then developed incontinence of urine and faeces. 15 days after the accident he suddenly developed paralysis of both the lower extremities with severe flexor spasms for which he was treated in the medical wards for three months. He had a course of curare injection of 5 c.c. I.V. on alternate days for 3 days and later 2 c.c. His complaint on admission was pain and tenderness over the lumbar spine and incontinence of urine and motion.

On examination, he was a well nourished individual.

*Nervous system*: All the cranial nerves were normal. Pain and light touch sensations were diminished in the right side in the region of L.4 and L.5 and on the left side at the level of S.2. Joint sense and sense of position were absent on both sides. There was a zone of hyperaesthesia at level of D.8 segment.

*Reflexes—Superficial*: Abdominal reflexes were normal. Cremasteric reflex was absent on both sides. Plantar reflex was extensor on both sides. Deep-Knee/jerk was exaggerated on both sides. Ankle jerks were normal. Viseral: Incontinence of faeces and urine were present. (Patient appreciated when micturition started but he was not able to control the flow).

Lumbar puncture was done thrice and showed a gradual increase in proteins. Fluid was clear and not under pressure. Queckenstedt's phenomenon was present.

February:

Total proteins — 40 mgms. %

Globulin — +

No cells.

March:

Total proteins — 60 mgms. %

Globulin — +

No cells.

Lange's colloidal Gold  
reaction was 003330000

April:

Total proteins — 80 mgms. %

Globulin — +

No cells.

C.S.F. W.R. — Anticomplementary.

Cistern puncture. Total proteins — 30 mgms. %

Globulin — Nil.

Blood W.R. Kahn — Negative.

X-ray of dorsal and lumbar spines — Nil abnormal.

Lipiodol was put in and it showed a partial block at the level of the sixth dorsal vertebra.

Under Intratracheal gas and oxygen supplemented by local novocaine, laminectomy was performed from the level of D.5 to D.9. When the dura was opened the cord was found to be oedematous. No tumour was found in the anterior or posterior aspect. Cord was feebly pulsating. Wound was closed in layers. Patient's condition was the same as before the operation for some time. Subsequently he became worse with bed lesion of the cord; the sudden onset of symptoms of spinal shock passing off after some time, slight improvements and lipiodol examination all tended

spinal shock passing off after some time, slight improvements and lipiodol examination all tended towards the diagnosis of a spinal vascular thrombosis. Naevi of the skin the common association of which with spinal vascular abnormalities has been described by Mason (1943) were absent in this case.

The patient died four months after operation and a partial autopsy showed the following interesting condition in the spinal cord.

Patient expired on 24-7-1947.

*Autopsy*: Partial autopsy was done two hours after death. The cord was exposed along the original incision. The dura was densely adherent to the cord over the site of operation, and the dura below was distended and tense with C.S.F. The dura on incision revealed a fusiform swelling of the cord lying between the 9th and 10th dorsal nerves. The Subarchnoidal vessels below this level were congested. The cord was removed (D2 to filum terminale) Section though the fusiform swelling shows a dilated cystic space 4 m.m. in diameter about 2 cm. in length rather eccentrically situated near to the left of central canal. Postero-lateral to this is seen a cleft with dark yellowish pigment. (The specimen is in the Madras Medical College Museum.)

*Microscopic appearance* shows a large cavity with no definite ependymal lining with Haemo-siderin pigment along the wall. Another cavity is seen on the postero-lateral aspect and a few more micro-cystic spaces are seen in the posterior columns on the Right side.

### A resume of other cases in the hospital and the mofussil.

As far as can be ascertained there had been in this hospital one case of extradural fibroma in a male, aged 20 (1935), a case of hernia of nucleus pulposus in a male in the lumbar region (1942), a case of intradural lipoma between L 4 and 5 in a male aged 15; a case of intra dural neurofibroma in a male aged 45 and a case of fleshy tumour, a large neurofibroma of the cauda equina, (1940) in a middle aged male under four other surgeons of the hospital.

There was a case of extensive arachnoiditis in a male after an operation under spinal percaine light solution. One case with 900 mg. protein in C.S. Fluid refused operation and went away from the medical wards. Two other male patients who were submitted to operation as tumour suspects did not reveal any tumour. One of them

proved to be an intramedullary Haeman-gioma at autopsy.

Four specimens of tumours of the cord were received during the past three years from two mofussil centres and they were (1) intra dural meninginoma of 4th dorsal in a male aged 14; (2) sarcoma at 8th D in a male aged 50; (3) intra dural neurofibroma of groundnut size in a male aged 22; and (4) lymphangio-endothelioma in a male aged 25. This does not include cases of two other teaching hospitals of this province.

#### A resume of other specimens in the Pathology Museum.

There is an undated autopsy specimen of a spinal cord with a tumour — glioma. In the lumbar region of the cord there is an oval whitish rather firm mass of the size of an arecanut. This is seen to grow from one of the nerves arising from the spinal cord at this region, is freely movable and is covered by pia-arachnoid. It is connected to the spinal cord. Microscopically section showed spindleshaped cells and triangular cells with fine processes — glioma. There is an autopsy specimen of a spinal cord (autopsy 13-8-45) with multiple neurofibromata. On the left side the lower four roots have neurofibromata; on the right side the two lowest roots; they are  $\frac{1}{2}'' \times 1\frac{1}{3}''$ ; most likely the nerves are involved for longer distances. There is a bulge under the dura between 10th and 11th roots and an inch above this there is an intra-dural tumour. Above this there is a narrowing of the cord and an inch above that there is an intra-dural bulge. There is a neurofibroma of the right fourth root. The clinical history in this case is: A male aged 40 was admitted on 6-8-45 in the medical wards for continuous fever of fifteen days duration with rigors and chills; there were numerous tumourlike masses all over the body: he died on the same day and an autopsy was done on 13-8-45. There was a cystic tumour with haemorrhages adherent to the under-surface of the liver and upper pole of the right kidney: the

right supra renal was absent—a supra renal tumour. The spinal cord showed multiple neurofibromata.

The photo shows the tumours in the specimen (Fig. 9). It would have been

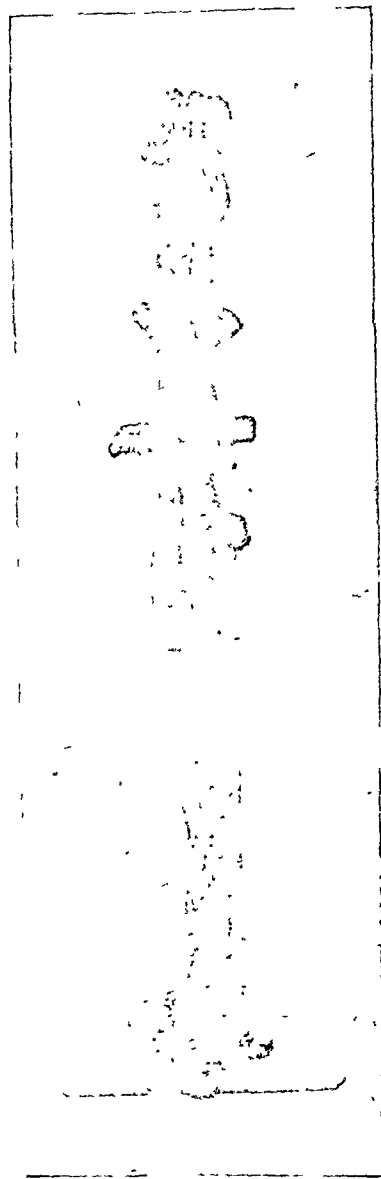


Fig. 9.

Autopsy specimen of cord from the pathology museum of the Madras Medical College  
Multiple Neurofibroma

difficult in this case to demonstrate the various tumours at different levels; if there was not a central line tumour there need not be much of hold up of lipiodol. It would be always well to know the lower levels of tumours. In my experience I had no pre-operative knowledge of the length of the tumours an ascending lipiodol from the lumbar region and X-ray examination will be of value also. Otherwise some of the tumours will be missed.

### DISCUSSION

Classification of primary spinal tumours for purposes of convenience is usually according to their site—1. Extra dural. 2. Intra dural (a) extra and (b) Intramedullary.

The general incidence of spinal tumour is much less than that of the brain — 1.9% of spinal to 9.1% cerebral tumours of admissions to National Hospital, Queen's Square. Elsberg had 175 cases in 14 years (12.5 per year). No special sex incidence has been remarked (all the cases noted in this series, however, are males). They may occur at any age, but are usually seen in the prime of life, (this is so in this series also) and differ from intracranial tumours in their comparative absence in children. In Elsberg's series 84% of the total fell between the years 21 — 69, the highest incidence (27%) being in the 5th decade. Only one was seen in the first decade. The relative frequency of the different types of tumour may be judged according to the site e.g. over one half of spinal tumours are intra dural extramedullary about 1/5 are intramedullary and the remainder are extra dural. Since there is a relation between histological type and tumour position, the frequency of the histologic types can be accordingly assessed. Intradural extra medullary tumours are usually fibroblastoma, meningioma, fibroma or neurofibroma. Sarcoma seldom appears primarily in the cord, while the commonest intramedullary tumour is the glioma. There is a remarkable difference in the incidence of glioma in the cord and in the brain so

that the cerebral triad of astro-cytoma, glioblastoma and medulloblastoma take a small place in cord tumours. The commonest cord tumour is ependymoma (more than 50%) which is a rare brain tumour. In this series of 7 cases (all males) there were 3 Neurofibromas, one meningioma, two fibroblastoma and one glioma.

*Clinical pathology:* Symptoms produced are due chiefly to pressure which varies according to the size and situation of the growth.

*Effects on neural parenchyma:* An intramedullary tumour must of necessity destroy neighbouring tissue as it enlarges, the damage decreasing in proportion to the distance from the growth. An extramedullary tumour seldom invades the cord, but pushes it aside as far as the anchoring nerve roots will allow. Tumours on the dorsal aspect of the theca have less pressure effects than anterior ones, as there is more space in the posterior half of the spinal canal. Tumours attached to spinal roots first irritate and then destroy the nerve fibres.

*Effects on blood vessels:* Tumours outside the cord interfere with its blood supply. There is first engorgement of meningeal and spinal vessels and later ischaemia which leads to necrosis.

*Effects on C.S.F.:* The first pressure effect is failure to transmit the respiratory and cardiac waves so that there is no pulsation. In a fairly complete block, the pressure below the compression will fall but in rare cases it may rise due to venous transudation. The changes in the C.S.F. are not specific and do not definitely establish the presence of a growth. These changes are (1) altered composition; (2) interruption of the free flow of the fluid. *The change in composition occurs early even before clinical block is manifest.* The chief feature is protein increase from the normal 35—40 mgm. to 100—500 mgms. or even more. One case of 3600 mgm. was reported by Spurling and Maddock. Intramedullary growths cause less protein increase than extramedullary and the same figures may be

obtained from a cervical as from a cauda equina lesion. Protein increase alone is characteristic though not pathognomonic of cord tumours.

Other, less important changes in composition are a yellow colour and spontaneous coagulation. This group of changes should not be called Froin's syndrome which also includes pleocytosis and which is seldom found in tumour compression due to adhesive meningitis.

Hindrance to the free passage of the fluid is proved by manometry. The normal pressure is 100—150 mm. of water, but may vary 20 mm. either way, so that any figure less than 80 below the seat of obstruction is pathological.

Pure manometry is not of much clinical value unless there is a complete block and in practice it is found that Queckenstedt's test is much more useful. This should be carried out with the patient in the horizontal position on his side with a manometer attached to the needle, allowing an appreciable interval for the fluid to settle down. Mere touch on the jugulars will now send the pressure up by 10 mm. and maintained pressure will increase it by 200—500 mm. On releasing the pressure, the fluid comes quickly and evenly down to the previous level. When there is partial or complete subarachnoid block—the fluid does not move freely or smoothly in response to jugular compression, takes a longer time to reach its maximum level and lingers in its descent.

- (1) The rise may not occur at all.
- (2) It may rise at the most 50 mm.
- (3) The ascent is slow.
- (4) The top level is maintained for a space after compression is released.
- (5) The fluid sinks slowly or by steps and does not reach the previous level.

A complete manometric test should include a record on an appropriate chart of:

- (a) the effect of light touch compression on the jugular veins.
- (b) the effects of firm compression for 10 seconds.
- (c) the time required for the rise of the column of fluid to its highest level.
- (d) the time required for the fall after deep compression has been discontinued.
- (e) the level to which the fluid falls.
- (f) the effects of straining.
- (g) the level to which the column of fluid falls after 7.5 c.c. of fluid has been allowed to escape. (Fig. 10 shows the manometric chart in an extra dural block.)

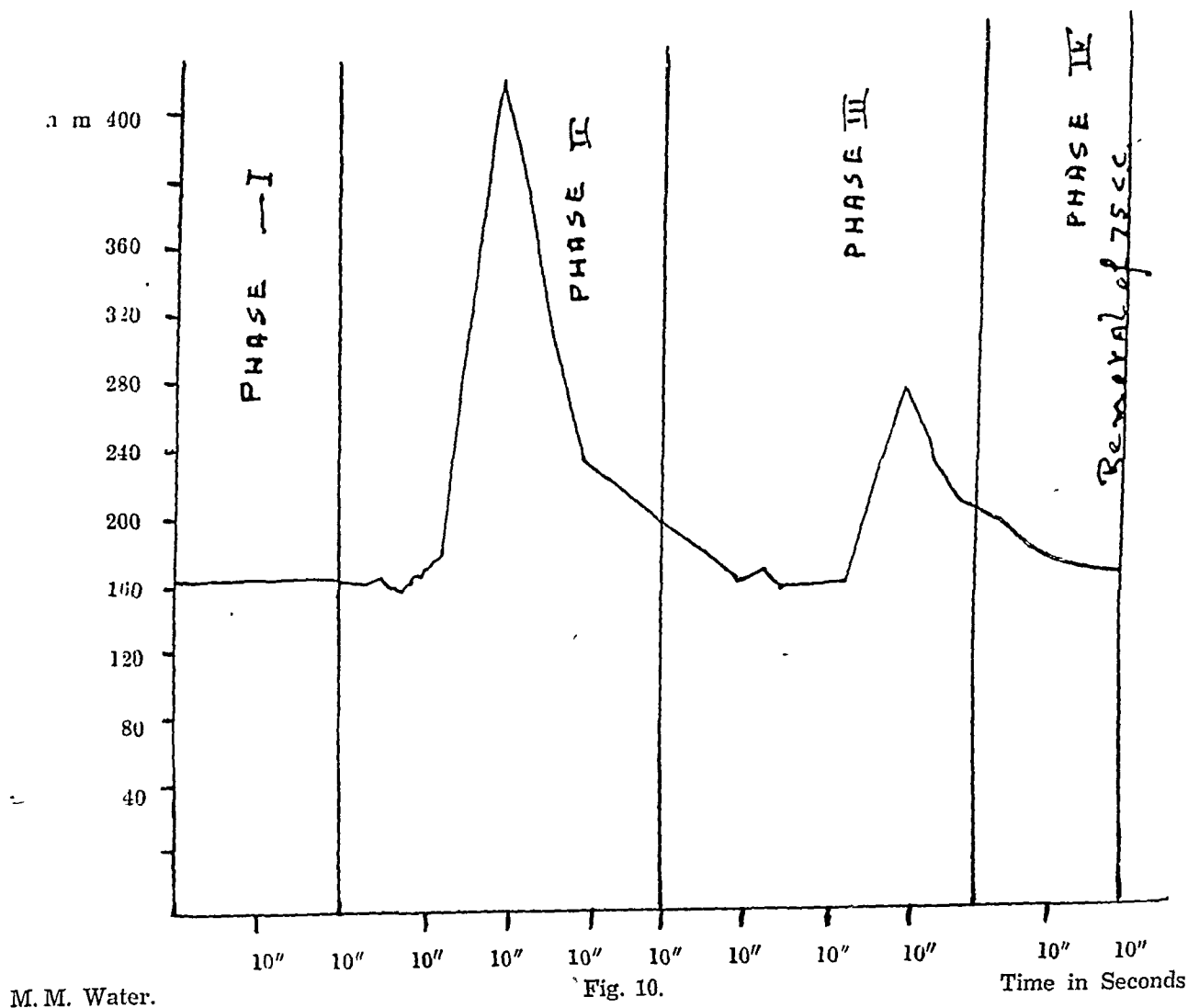
The same type of test may be carried out by raising the intra cranial tension with inhalation of amyl nitrite glass pearls containing 5 mms. of amyl nitrite. One pearl is broken and inhaled for 30 seconds by passing it from side to side under the patient's nose. Manometric readings are taken every 5 seconds during inhalation and thereafter till the pressure had fallen to the pre-inhalation level—usually 3 to 4 minutes. Inhalation is begun during inspiration. When there is a block in the subarachnoid space the jugular test shows:

- (1) Complete block when there is no rise of the fluid on both touch and deep compression, and when after removal of 7.5 c.c. of spinal fluid—the fluid does not fall to a new level.
- (2) Partial block (a) total rise of the column of fluid of less than 100 mm. and a rise of the level *during* inhalation of the drug, 20—30 mm. (b) a rise of between 100—105 mm. and a total rise *during* the period of inhalation of the drug of not more than 20 mm. and a delay in the beginning of the rise of at least 10 seconds (Elsberg).

Symptoms vary considerably with the size and especially, longitudinal extent of the growth. On the other hand a tumour

may be long but its thickness may vary in different parts, so that different parts of the growth may exert a varying amount of pressure or only one part of the tumour may actually compress the cord. This accounts for the marked variation seen in the combination of symptoms. A tumour

lying over certain segments of the cord, may not actually involve all those segments so that the signs produced may not extend as high as the tumour itself. This accounts for the discrepancy between the level of signs of some growths and their exact location.



Manometric Chart in an Extradural Block.

Note the delayed rise which is characteristic.

In an average case however the symptoms are (a) local symptoms at the level of the tumour and (b) concurrently or soon after, symptoms below level of lesion due to pressure on tracts irrespective of whether spinal tissues are compressed from within or without.

1. *Sensory root symptoms.* Root pain is the earliest and most frequent symptom. It may involve one or more roots and is more commonly noticed in fibroblastoma (Case No. 2). Local spinal pain, tenderness and soreness over the site of the tumour is often noticed, especially in cauda equina lesions (Case No. 3).



Various explanations of this pain, such as irritation of nerve filaments, have been put forward but lack conviction. Sensory root symptoms appear more often because fibroblastoma generally lies on the dorsal or dorsolateral aspect of the cord.

2. *Sensory cord symptoms.* Tumours growing inside the cord do not produce root pain but a central type of pain referred to a whole limb may occur. Paraesthesias when due to a cord lesion often begin in the periphery, e.g. ascending from toes to trunk in steps. In some cases the Brown Sequard syndrome is found.

In many cases there is a combination of sensory and cord symptoms, a fibroblastoma usually causes root symptoms first while a glioma causes cord symptoms first.

3. *Motor root symptoms* are irregular in appearance are not early and do not show till more than one root is affected. The first sign is weakness of a group of muscles leading to atrophy a moderate progressive lower motor neuron lesion and has a prime localising value.

4. *Motor cord symptoms* are due to derangement of pyramidal tracts by compression, e.g. a monoplegia or paraplegia. In many cases there are motor root symptoms at the level of the lesion and motor cord symptoms lower so that it is possible to assess the site of the lesion.

5. *Reflexes.* Tendon reflexes are exaggerated below the obstruction. Organic reflexes depend on the situation and evolution of the tumour. If above the lumbar enlargement, the bladder may become automatic or overflow from fullness. Only if the vesical centres in the cord are damaged does dribbling incontinence occur.

6. *Trophic lesions* may be due to neurosympathetic damage and predispose to bedsores. Trophic ulcers over the sacrum, buttocks and heel are common in lumbosacral and cauda equina lesions but are very rarely seen in lesions of other parts of the cord, e.g. cervical and thoracic. In these cases it is extremely rare to find trophic

disturbances unless the skin has been injured. This contrasts markedly with what may happen after operative interference where there may be a certain amount of acute trauma to the cord. Case 1 illustrates this fact.

The cases presented in this paper have several interesting features.

1. Their ages were 35, 25, 29, 31, 42, 60 and 40 except one all in early manhood—all being males.

2. *The symptoms varied in each case—*

(a) Case No. 1 showed a cord type of lesion. He had no root pain, but had local pain over the site of the tumour. The extensive nature of the growth explains the widespread paralysis which did not recover with decompression.

(b) In Case No. 2 the patient came in an advanced state of paraplegia which was mistaken for spinal syphilis because of a positive Wassermann result and the presence of cells in the C.S.F. C.S.F. protein was 600 mg. %; Xanthochromic but no clotting was present. The earliest symptom was root pain, followed by ascending paralysis in the lower limbs, and finally disturbance in bladder and rectal functions; a band of hyperaesthesia at the level of the nipple helped to fix the level of the lesion. The nature of the growth (fibroblastoma) might have been presumed from the clinical history of root symptoms followed by cord symptoms, while central glioma produces first cord and then root symptoms (Elsberg).

(c) In Case 3, the only symptom was severe root pain and local tenderness over the spine combined with gluteal wasting so that this patient might have been overlooked as sciatica, if he himself had not insisted on obtaining relief. C.S.F. was yellow with 100 mg. protein but no spontaneous coagulation. The large soft tumours of the cauda equina (as in this one) often fill the entire lower end of the spinal canal and cause very slowly progressive symptoms for several years. They often exist

without any objective sensory symptoms and may cause only motor disturbance. In this case the only signs were root pain (subjective sensory) and gluteal wasting (motor) on the contralateral side. There was at first a mistaken diagnosis of tuberculosis of the spine.

(d) The 4th case came with paraplegia with positive Wassermann mistaken for spinal arachnoiditis. A high protein content 1500 mg. % with 3 cells was the decisive feature in introducing lipiodol to demonstrate the block. The case was treated as spinal syphilis for a long time.

(e) The fifth case was one of increasing disability with marked irritative symptoms which had been diagnosed at various times in the course of 12 years as peripheral neuritis, ichthyosis, progressive muscular atrophy and disseminated sclerosis. The C.S.F. protein was 80 mg. % on the first L.P. as early as twelve years ago and should have aroused the suspicion of a spinal tumour. Trophic lesions set in in this case for the first time after operation.

(f) The sixth case had severe root pains with a localised tumour which was partially excised elsewhere and proved to be a neurofibroma with extensions into the vertebral foramina and intercostal nerves.

(g) The seventh case was also treated for Syphilis.

3. *The C.S.F. findings* in these seven cases are also worthy of notice. In every case lumbar puncture was performed between the 3rd and 4th spines. In all the cases the fluid was apparently not under pressure, and did not clot except in the 4th and 5th cases. In the first 4 cases fluid was Xanthochromic. Only in Case No. 2 were there cells, and this contributed to an erroneous diagnosis of spinal syphilis. The protein excess was remarkable in all cases excepting No. 1.

In the case of hypertrophy of the ligamentum Subflava, the lipiodol radiogram was not characteristic. In Case No. 8, one of the two cases of compression syndrome

where no tumour was detected during the operation, there was a strong suggestion of a Syphilitic lesion; the difference in the protein contents of C.S.F. obtained by cistern puncture and by L.P. and the partial hold up of Lipiodol however made the diagnosis of tumour reasonably certain. The other Case No. 9 showed a progressive increase of C.S.F. protein from 40 to 60 and 80 mg. % at intervals of a month and a difference in protein between cistern C.S.F. and L.P.C.S.F. (30 mg. and 80 mg.) and though there was no hold up of Lipiodol, a spinal exploration seemed to be indicated.

There is a considerable literature on vertebral angiomata but not on vascular lesions of the cord. Many cases of paraplegia till now included under the term Myelitis are probably examples of vascular abnormalities.

R. Wyburn Mason (1943) has classified the vascular abnormalities in his book and described typical clinical syndromes with notes on the pathology, verified in many cases, at autopsy. Sixty seven cases are described fully with operation and, in some, autopsy notes. The operation findings are instructive and will repay careful study by all those interested in spinal tumours.

186 cases of vascular lesions have been described in the literature so far. Wyburn Mason's classification and a few relevant facts under each condition may be of interest and are reproduced below:—

—(A) abnormalities:

- (1) a. venous abnormalities below a tumour of the cord.  
b. extensive venous varicosities.
- (2) arterio venous angioma.
- (3) arterial abnormalities associated with congenital heart disease or alone.
- (4) syphilitic aneurysm of spinal arteries.
- (5) Telangiectasis cavernous angiomata.

## (B) True tumours:

(1) (Haemangio-blastoma or Haemangio-endothelioma) which may be extra dural or intra dural.

(2) Lymphangioma.

The frequency of vascular lesions may be judged by the fact that Adson found that of 557 intraspinal lesions, 8.5% belonged to the group of extramedullary vascular tumours and that of 64 intramedullary tumours, 7.5% were vascular in nature.

Enlargement and engorgement of veins occur below the tumour due to the obstruction to the venous circulation, whenever pressure occurs in the cord from an intraspinal or vertebral tumour. A similar enlargement and engorgement occurs in association with arachnoiditis or arachnoid cysts, but is probably caused by venous obstruction caused by kinking of the vessel walls: calcification occurred in the cord following trauma in a case and this was associated with enlargement of veins.

Angioma racemosum venosum is the commonest type of vascular abnormality of the cord. It also seems to be associated with tumour in 3 to 4% of cases. Adson & Otto met it three times in 112 laminectomies for spinal tumours, and in 4 more it was found at autopsy.

78 cases are described of this type. The pathological effects are seen in the lower part of the cord and in no case has it extended higher than the D 6-5 segments. On reflecting the dura the lower part of the cord is usually seen to be covered on the dorsal surface by a mass of sinuous anastomatic, turgid, blue pial veins. They are often in two layers and completely hide the cord. On microscopic section of the involved regions abnormal vessels are seen extending from the anterior median fissure into all parts of the grey matter and white matter adjacent to it. The nervous tissue is replaced by numerous blood vessels, chiefly capillaries, precapillaries and venules, which destroy the cells of the grey-matter and cause

degeneration of white-matter with considerable gliosis in many cases.

The course, sex, age incidence, C.S.F. changes and pathological changes are identical in acute necrotic myelitis and angioma racemosum venosum. The first appearance of symptoms is due to thrombosis occurring in one or more vessels and the characteristic progression of the condition in successive waves corresponds to the occurrence of successive thromboses. Trauma may initiate the thrombotic process; operation will be of no benefit to these cases.

*Characteristics of the disease* are discontinuity of symptoms and progression a series of apoplectiform stages or "episodes" at first possibly with almost complete recovery between the attacks, but, sooner or later, permanent symptoms. All these manifestations occur below the middle of the body. In 3/5 of the cases the onset is sudden acute pain of a root type, either the lower portion of the trunk or the legs. Commonly it is diagnosed as Sciatica; this pain may be severe and is a prominent feature of the illness, may disappear and come back, and is possibly due to the pressure of the engorged veins on roots. Pain varies when the patient moves from the horizontal position and is completely relieved by standing up. The onset of the pain is associated with weakness or complete paralysis of one or both legs, numbness and paraesthesia in part or whole. Sphincteric disturbances may be present. Symptoms come on rapidly. Sensory losses of the dissociated type pain and temperature being affected, while appreciation of posture, vibration and touch are well preserved; but sometimes they are slightly disturbed also. At this acute stage of spinal shock the deep reflexes are usually diminished or lost in the affected limb or limbs, but after a short time when the shock has passed off another characteristic finding of the disease, namely, flaccidity and wasting of some muscles with diminution and loss of tendon reflexes, spasticity and increase of reflexes in other segments of the limb,

extensor plantars and loss of abdominal reflexes appears. Thus there is a mixture of upper and lower motor neurone disturbances in the lower limbs. The commonest muscles to waste are those of the buttock, calf and hamstrings on one or both sides. After the stage of spinal shock has passed off the sphincter disturbance often improves and may disappear. At autopsy thrombosis of the dilated and abnormal vessels are found.

*Associated Lesions.* Vascular naevi of the skin have been present in several cases. In one case the naevus was in a skin dermatome on the back corresponding with to the cord lesion.

*Course.* In the 16 patients dying without operation, the course varied from 3 months to 24 years, the average being about 7 years. This is much longer than the course of most spinal tumours, but some cases run a very rapid course in 3—6 months.

*C.S.F. Examination.* By lumbar puncture in 17 out of 32 cases the fluid was normal; in some cases there were 11 to many lymphocytes during the time of the episode; the lymphocytosis is probably evidence of a recent thrombosis in the affected veins and tends to occur in the more acute cases. In 36 cases there was an increase in the protein from 90 mg. to about 1500 mgs. %. In several cases spontaneous coagulation occurred. The amount of protein is unrelated to the presence of block in the subarachnoid space. Xanthochromia was present in 12 cases only. This may be found whether block is present or not and it is unrelated to the amount of protein in the fluid. Queckenstedt's test was positive in 5 cases, i.e., the pressure did not rise, and was negative in 19 cases. Of 5 cases of cistern puncture, in 2 C.S.F. was normal and in 2 cases the protein was increased in the absence of shock. Lipiodol intrathecally was performed in 19 cases. In 10 cases there was no hold-up whatever. The appearance resembles in some ways that seen in spinal arachnoiditis; the oil is held

up over several segments of the cord, either completely or partially in the form of small droplets.

30 cases of arterio-venous angioma are described. Sex incidence is almost equal; in most patients the first symptoms appeared early in life but often no great disability occurred until much later. Two regions of the cord are specially affected, the posterior portion from the 7th thoracic to the upper lumbar segments, and the anterior portion of the cervical enlargement; one side may be more severely affected than the other. During the lipiodol examination visible pulsation under the X-ray screen and by Kymography may be noted. This appearance is only seen if the patient is slowly moved from the horizontal position; if the movement is done rapidly the oil may drop too quickly and the pulsation and hold-up missed.

Six cases of arterial abnormalities are described. The cases in which spinal cord compression is associated with congenital heart diseases are of two kinds. (a) those associated with coarctation of the aorta (b) those associated with some type of congenital heart disease; the spinal arteries are affected on account of the collateral circulation giving rise to tortuosity and enlargement of those vessels.

A careful clinical and radiological examination of the heart, where an obscure spinal cord lesion is present is therefore necessary.

Similar to spontaneous intra cranial sub-arachnoid haemorrhage, spontaneous spinal sub-arachnoid haemorrhage also occurs; it may occur suddenly without previous syndrome or during the course of a progressive spinal lesion or as a terminal event. Telangiectasis, both intra medullary and epidural has been described. There is relationship between this and the multiple hereditary telangiectasis. There is association of telangiectasis, lipomata, meningiomata, osteoma and skin naevi indicating a disturbance of mesenchymal development.

Haemangioblastoma and multiple angiomas have been described; this is twice

as common in males as females, when the cord is affected; the average age is 32—the youngest being 9 and the oldest 58 years. The age incidence is almost entirely in the third, fourth and fifth decades. (Mason)

*Operative technique:* The first case was operated on under intra-tracheal  $C_2E_3$  but the other two were given rectal ether in oil supplemented with light ether inhalation and combined with local nerve block with  $\frac{1}{2}\%$  solution of novocaine. The other cases were done under intratracheal gas and oxygen combined with local novocaine. This anaesthesia proved very comfortable for patient and surgeon and there was very little operative shock.

In removing the laminae, especially in the thoracic region, it was found that the removal of both spines and laminae is easier in a cephalad direction. This is because the thoracic vertebrae are more fixed and the spinous processes and laminae overlap. In all the cases it was noticed that there was a distinct narrowing of the cord above the growth so that an hour-glass like appearance was noticed. In cases Nos. 2 to 6 the tumours extended more anteriorly than posteriorly, so that the cord had to be deliberately turned and the anterior aspect inspected. The tumour in case No. 3 (cauda equina) and 5 and 6 would have been missed if this had not been done, as they were completely anterior and were covered on the posterior aspect by the nerve roots.

The prognosis of a case submitted to surgery depends on the following points:

- (a) The nature of the growth.
- (b) The stage at which the surgeon interferes, and
- (c) The amount that he is able to remove.

Case No. 1 showed no improvement, the growth was an extensive neuro-fibroma about 4—5" long producing erosion of the vertebrae on all aspects and widening of the spinal canal—proved fatal on account of paraplegia and extensive trophic lesions.

Case No. 2 has recovered considerably and it is hoped that the recovery will be complete, as though late the tumour (a benign one) was completely removed.

Case No. 3 shows the best prognosis as the tumour was completely removed at an early stage. At present, the root pain has completely disappeared but sensation over the sole of the left foot is impaired.

The fourth case has improved. Spasms have completely disappeared. Paraplegia is recovering. He has been fitted with boots and irons to prevent foot-drop and he is on his legs with crutches.

The fifth case showed initial improvement. The spasms did not entirely disappear although it was 80% better. He was able to pass urine but rectal sphincter was very lax and he had pressure sores over the right trochanter.

The sixth case proved fatal on account of bilateral pneumonia, finally he succumbed to the effects of extensive bed sores.

The seventh case had a smooth post-operative course; but there was no improvement in function.

*Diagnosis of early cases.* In considering these cases one notices that the progress of symptoms is slow, and one is stimulated to look for some method of diagnosing cases in the very early stages. C.S.F. changes and pressure symptoms on root and fibre tracts can presumably occur only after a long time and the aim should be to diagnose these conditions even before pressure symptoms occur. In this endeavour it is useful to consider a few anatomical facts.

1. In the cervical region the nerve bundles remain distinct until they have passed through the dura, the bundles originating from the cord being spread out like a fan with the broadest part at the cord. The dorsal and lumbar roots are formed by nerve bundles which soon unite to form the root that passes as one bundle to the dural opening. From this arrangement in the cervical region a tumour may for a long time press upon only a few of the bundles

which compose the root, while in the thoracic and lumbar regions a tumour may from the beginning press on the entire root.

2. Normally the spinal cord is mobile both in longitudinal and transverse directions. In abnormal conditions movements of the spine may produce disturbances both in the fixed part of the cord and in the affected nerve roots, so that part of the spine is unconsciously held rigid. This stiffness of the spine is often a defensive reaction on account of radicular pain. These facts should be borne in mind in the diagnosis of back-ache and suspected cases of spinal tuberculosis.

3. During forced expiratory movements such as sneezing, coughing or straining, the mobility of the cord and the potency of the sub-arachnoid space is sufficient to prevent any radicular disturbances. When the C.S.F. is expelled from the cranial cavity into the sub-arachnoid space, when the cord is fixed by disease, or the sub-arachnoid space is partially or completely obstructed, the sudden passage of C.S.F. into the spinal sub-arachnoid space results in the sudden stretching of the posterior spinal roots at the affected level and as a result, sudden pain in the back or pain of radicular distribution occurs. In an expanding lesion of the spinal canal, the pain on forced expiration may be due to the sudden impact of the tumour on a posterior spinal root.

4. The arrangement of nerve roots are as follows:—

(a) The cauda equina. The most medially situated are the lower sacral roots, the lumbar being more laterally placed. Many cauda equina tumours spring from the mesian filumterminale.

(b) The posterior white columns. The fibres from the sacral areas lie nearest the middle line and most ventral, while the fibres from areas above the sacral take their position outside of and posterior to the sacral fibres.

(c) The pyramidal tract. In the antero-lateral column the fibres have a lamellated

arrangement, those supplying muscles at a higher level lying more medially to those supplying muscles at a lower level.

5. The spinothalamic pathway. The crossing is immediate in the same cord segment. There is lamellation of fibres in the spinothalamic pathway. The fibres which convey sensation from the most caudal skin areas lie in the posterior and outer parts of each tract, and those which join at higher levels, take a position somewhat anterior and internal to the ones already in the tract.

Bearing these facts in mind it is possible to lay down some principles in the early diagnosis of spinal tumours:—

1. In the absence of other disease, a persistent neuralgia must always be looked upon with suspicions that the pain may be of spinal root origin (Elsberg).

#### FIRST SYMPTOMS OF 64 cases OF SPINAL TUMOUR (Table modified

from Ayer (Kinnier Wilson)

SYMPTOM	TYPE OF GROWTH		
	Intra-medullary	Extra medullary Endothecal	Extra-dural (vertebral)
<b>SENSORY</b>			
Root pain ...	6	18	1
'Spinal pain' ...	7	5	—
Paraesthesia ..	5	5	2
<b>MOTOR</b>			
Weakness or paralysis...	2	13	4
Spasm or trembling ...	2	—	1
Unsteadiness ...	—	3	—

The patient may have to be observed for a long period as it often requires a long time for cord symptoms to appear.

2. If coughing, sneezing or other forced expiratory movements aggravate the neuralgia the possibility of a spinal root lesion is considerably nearer.

3. Cutaneous hyperaesthesia of a radicular type points to a spinal root origin of

the pain, especially if coupled with muscular atrophy of the radicular type (Case No. 3).

4. In cases where neuralgic pain is the only symptom, careful search should be made for slight sensory or motor disturbances below the lesion. If tendon reflexes are found to be more active on the same side as the root symptoms, *no matter how slight*, the diagnosis of a growth in the spinal canal is probable.

5. When radicular neuralgia is diagnosed and found to persist or worsen examination

are most useful for determining this. According to Elsberg and Dyke the width of the spinal canal corresponds accurately to the space between the most medial borders of the vertebral pedicles. Generally speaking, the more localised the enlargement of the spinal canal, the more likely it is to be due to a pathological process.

7. Lipiodography. Elsberg states that lipiodography is resorted to more frequently than necessary because the spinal manometric tests are not carefully carried out with full appreciation of the time element, so that partial sub-arachnoid blocks are

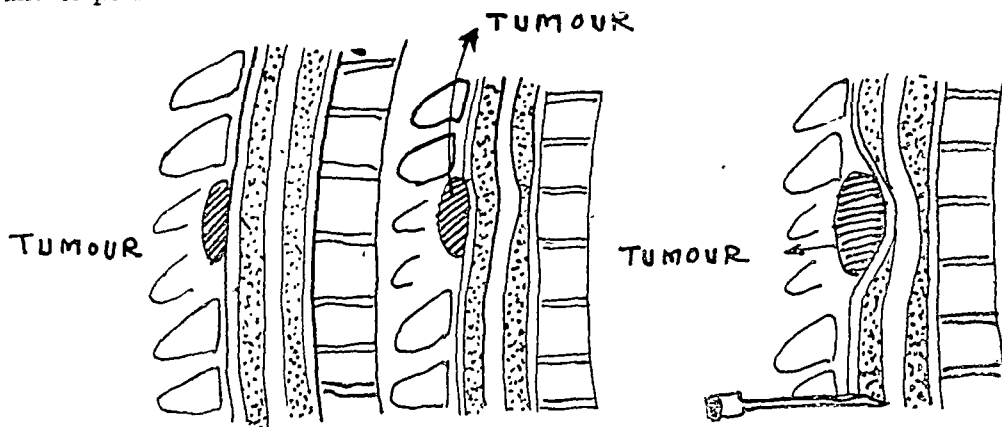


Fig. 11.

Schematic Drawing showing relation of an Extra Medullary Tumour to the Spinal Cord after removal of the Fluid Buffer.

of the spinal fluid with manometry as detailed here is equally important as X-ray examination and a complete examination of the patient should be recorded before and after the lumbar puncture. In this way indefinite level lesions may become more evident, or existing signs be aggravated.

6. X-ray examination must always be made carefully in the diagnosis of early cases, for hitherto unsuspected bone disease. The measurement of the interpediculate spaces should never be omitted. The interpediculate distance is the space between the most medial points of the pedicles of a single vertebra. X-rays of the spine taken in the antero-posterior position

missed. He opines that in all cases careful spinal manometry will give all information without having recourse to cistern puncture or lipiodol. He also states that even in the hands of experienced surgeons he has known of several cases where bleeding occurred into the fourth ventricle after cistern puncture.

When using lipiodol the light solution should never be used as a considerable amount may enter the cranial cavity and find its way into the intracranial fluid spaces. The heavy solution (40%) may be removed by making the patient sit vertically, making a burr hole in the arch of the 2nd sacral vertebra, and withdrawing the oil by suction.

**Differential diagnosis :** The early signs of spinal cord tumours are determined largely by the position of the neoplasm in relation to the cord and emerging nerve roots. A tumour arising from a nerve root may give symptoms referable to the nerve root long before there is any evidence to suggest spinal cord involvement.

In early involvement of nerve roots within the vertebral canal without obvious compression of the cord, the early signs are referred to the peripheral distribution of nerve roots and the symptoms may be confused with those referable to disturbed functions of the kidney, gall-bladder, appendix, prostate, etc. 8th cervical root gives pain in the hand, 4th thoracic root may cause pain in the breast while lesion of the 7th and 8th thoracic roots on the right side simulates a lesion of the gall-bladder.

A tumour on a nerve root may exist for a long time without producing definite sensory changes referable to the root involved or if the tumour arises from the motor root before it has joined the sensory root, the earliest sign may be atrophy, fibrillary twitchings and weakness of the muscles supplied by the root. If both sensory and motor roots are involved there will be sensory and motor disturbances and atrophy appearing in the region in which pain is felt. (Fig. 12-A)

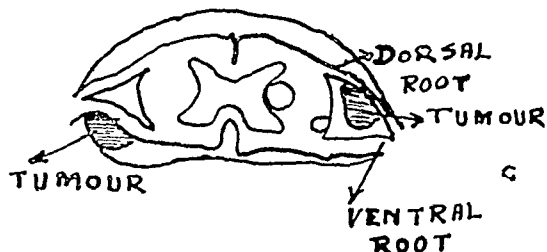


Fig. 12a.

Extra medullary cord tumours may present two groups of symptoms, the long tract syndrome (Fig. 12-C) and the root syndrome, either or both of which may be present.

Intramedullary tumours present the so-called central grey syndrome (Fig. 12-B) which is a combination of bilateral radicular

symptoms and the symptoms of long tract compression. Tumours of the cauda equina are large soft jelly like masses surrounding the nerve roots and producing radicular signs. It is important to note that on account of their soft jelly-like consistence,

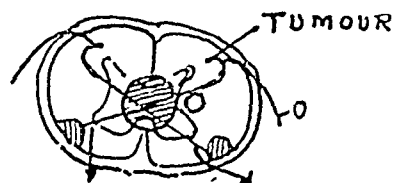


Fig. 12b.

Crossing Fibres to Spino Thalamic Tracts.

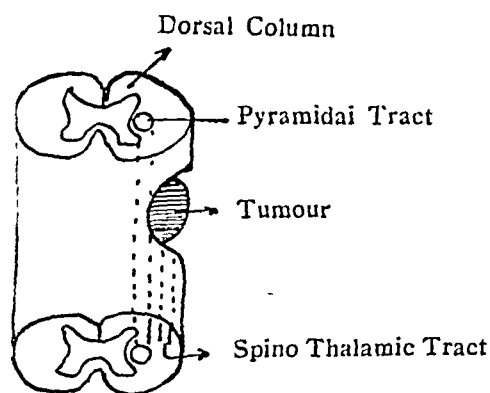


Fig. 12c.

Schematic diagram to show the relation of Tumours to the Spinal Cord and the Nerve-roots of the Long Fibre Tracts.

- A. Radicular Syndrome.
- B. Central Gray Syndrome.
- C. Long Tract Syndrome.

pressure may be exerted on the roots for many years, with only vague signs to suggest the presence of a tumour (Case No. 3).

Because of their symptoms, intramedullary tumours have frequently been mistaken for chronic poliomyelitis, syringomyelia or some other form of intrinsic disease of the spinal cord. Most chronic intrinsic diseases of the spinal cord do not materially increase the size of the cord or make it fill the vertebral canal within whose rigid walls it is enclosed. Spinal cord tumours are expanding lesions and form an obstruction like a dam which obliterates the sub-arachnoid space, preventing the flow of the spinal fluid. Intrin-



sic diseases do not cause obstruction of the sub-arachnoid space, block of the spinal fluid or compression of the cord itself. The lesions producing sub-arachnoid block are spinal cord tumours, inflammations, both acute and chronic, displacements of the vertebrae, or intervertebral discs and hypertrophic arthritis.

### SUMMARY

1. Seven cases of spinal cord tumour are described in detail; other cases of this hospital and specimens received by the Pathology department are mentioned.

2. One case of hypertrophy of ligamentum subflava is described.

3. Two cases diagnosed as spinal cord tumour are described where no tumour was detected. These two cases may be classed as vascular lesions of the cord producing compression syndrome.

4. An attempt is made to emphasize a few points in the early diagnosis of cord tumours.

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## PERITROCHANTERIC BURSITIS

by B. N. BALAKRISHNA RAO, Basavangudi, Bangalore, S. India.

### Introduction

Disabilities of the inferior extremity could be of serious import, even though the causative pathological processes by themselves may be mild. Disabilities round the hip are numerous, (excluding those of the joint and the bones) but have been paid little attention, probably on account of the fact that they do not cause the same degree of active or serious loss of earning capacity, as in the case of the disabilities round the shoulder. Consequently the disabilities round the shoulder have received greater study, while similar changes round the hip have been unnoticed. In the inferior extremity the diseases of the hip and other joints have so dominated the field, that minor disabilities have been overshadowed to some extent: none the less these disabilities are real and cause considerable pain and discomfort and diminish the efficiency of the person.

In this paper one such disability is described with a few unusual features that came under our notice.

Bursae are to be found in many parts of the body: due to irregular contour of bones or oblique lines of force, or where one structure has to rub over another and a smooth movement is desired bursae are present. Many are present at birth, a good few are constant in their position and structure, a few inconstant and variable, and a number develop as adventitial bursae. The bursae round the great trochanter of the femur are fairly constant in their position and structure, and changes in these bursae are of interest not only because they may simulate hip joint disease, but the disability these bursae produce is curable in the majority of

cases, if the pathological processes are correctly appreciated.

Chronic inflammation of bursae is of frequent occurrence, and of those round the trochanter are not usual, especially so with calcification. Nilsson reported a case of calcified trochanteric bursitis in 1930, in the *Acta Orthopaedica Scandinavica*, under the title 'Tendinitis calcificans trochanterica', and claimed that his was the first operated case reported. Although this claim is not strictly correct, it is true that in the present century this subject has received slight attention.

The meagre attention paid to this condition and the very few reported cases in the literature in English and in the prominent continental languages, prompted the publication of this paper to draw the attention of surgeons in this country.

### Trochanteric Bursae

Anatomical descriptions of the bursae round the great trochanter are rather inaccurate and not sufficiently detailed. Three bursae are almost always present in the neighbourhood of the great trochanter and are closely related to the musculo-tendinous insertion of the gluteus medius muscle. Of the three bursae, one lies between the gluteus minimus and the great trochanter, which is inconstant: another lies between the gluteus medius and the great trochanter. Often these two communicate with each other. The third bursa lies under cover of the gluteus maximus, partly overlying the insertion of the gluteus medius and partly directly over the trochanter itself. This is a large and constant bursa and is multiloculated, and very often the seat of inflammatory changes either primarily in itself or secondary to patho-

logical changes in the great trochanter which lies under it. This bursa is peculiar in that, it may be the focus of a tuberculous lesion, and may be the cause of a persistent sinus on the lateral aspect of the thigh, without the trochanter being affected. Thus a variety of tuberculous inflammation of this bursa is frequent, and it has not been explained as to why this bursa alone has a predilection for a tuberculous lesion. While tuberculous infection of the bursa as a result of spread from tuberculous osteomyelitis of the neighbouring great trochanter is understandable, it is strange that tubercle bacilli should settle down in this bursa without affecting the more vascular structures in the neighbourhood. Whatever may be the reason, it may be justifiable surmise to think that the same factors may facilitate the deposition of calcium in the bursa.

Calcification in non-osseous skeletal tissues has been the subject of great controversy and of diverse views and theories. Leriche and Policard are of the opinion that such calcification and later ossification is always the result of trauma. The trauma may have been so slight, or may have occurred such a long time before symptoms manifested themselves, that the patient may not correlate the trauma to the present complaint. According to Leriche the sequence of events are trauma, haemorrhage, organisation and at times calcification and ossification. While the trauma may be forgotten, the haemorrhage and organisation would produce symptoms not always easily forgotten by patients, and it is difficult to subscribe to Leriche's view regarding calcification. Moreover, a few bursae like the prepatellar bursa and most of the adventitial bursae, themselves the result of repeated trauma, are predisposed to repeated injury; these seldom deposit calcium. Therefore, it appears that the reason why calcification occurs in tissues should be sought in causes other than in trauma and haemorrhage. In the two cases described here, in one the onset of trouble was undoubtedly traced to an acute single trauma,

and in the other no history of trauma could be elicited after careful interrogation.

Tuberculous infection of trochanteric bursae appears to be frequent. If tubercle bacilli favour a vascular tissue for its focus of lesion (e.g. lungs, kidneys, ileo-caecal region, etc.) then it is strange that this bursa, a relatively avascular tissue should be a frequent site. The combination of tuberculous predilection and tendency for calcification may not be mere coincidence, and needs further elucidation. In the following two cases, as well as in the case of Lecocq, the investigations for tuberculosis were negative.

### CASE REPORTS

#### Case 1.

P., male, 25 years of age, unmarried, employed as a wrapper in a beedi factory was hospitalised on 14-4-45 with a complaint of swellings on the upper part of both the thighs, and difficulty of sleeping on the sides. The left swelling was of nine months duration and the right of six months. Family history was negative in relevant details. The present complaint started when about nine



Fig. 1.

Case 1. Showing shadow of calcified bursa overlapping the great trochanter.  
(Slightly retouched)

months ago he noticed a small lump on the left side in the upper part of the thigh in the neighbourhood of the trochanter, which has gradually

increased to the size of a big orange. It was freely movable and was never painful, but he could not lie on the left side. Six months ago he noticed a similar swelling on the right side in the corresponding part, which was also freely movable, and painless.

On examination there was a globular swelling on the lateral aspect of each thigh at the level of and overlying the great trochanter of the femur. The swelling was lobulated, hard in some areas and there was a gritty feel. The skin was not adherent to the swelling, and the swelling moved freely over the underlying bone. The left swelling was slightly larger than the right.

Roentgen investigation showed a large fluffy shadow in the region of the great trochanter, and on account of its size, its relation to the trochanter could not be definitely established. The trochanter itself appeared normal. The shadows were in the soft tissue and were deposits of calcium, and there was no evidence of ossification. (Fig. 1).

No definite preoperative diagnosis was arrived at, though a probability of a calcified bursa was entertained, a calcifying chondroma could not be ruled out, even though the swelling was movable over the underlying bone.



Fig. 2.

Case 1. Showing surface of bursa after removal.

Under spinal percaine anaesthesia, the left side was operated on on 16-4-45. At operation the swelling resembled a lipoma with large areas of calcification. It was well encapsulated and was removed entire. On section it felt gritty, and white thick curdy fluid, like barium emulsion escaped. Convalescence was uneventful.

#### Description of Specimen:—

The gross specimen shows a lobulated tumor 12 by 8 by 4 cms. and weighs 297 grammes. Lateral surface is convex with several fluctuant areas, some of which have ruptured. Medial surface is flattened with a slight concavity about the centre.

Tumor is well encapsulated. On section in the sagittal plane, the cut surface presents a well defined fibrous capsule, uniformly thick except for a few areas in which it is extremely thinned out and ruptured. A thick fibrous septum is seen to divide the tumor into unequal lobes. Numerous intersecting bands of fibrous tissue are seen dividing these two lobes of the tumour into several unequal and roughly spherical loculi. These are filled with opaque pale yellow masses, which on closer examination are seen to consist of loosely adherent concentric laminae of the same opaque pale yellow material. Along the peripheral portion of the tumor, beneath the thinned out portion of the capsule, cystic spaces of varying size are seen, partly filled with a pale yellow pasty material of gritty consistence, calcareous in nature. Calcification has supervened on degenerative changes in the bursa. (Figs. 2 and 3).

The microscopic appearances were similar to those in the next case, which is described in detail below.

Due to reasons beyond our control, the second tumor on the right side was not removed, and the patient was discharged from the hospital on 28-4-45, and subsequent attempts to trace his whereabouts have failed.

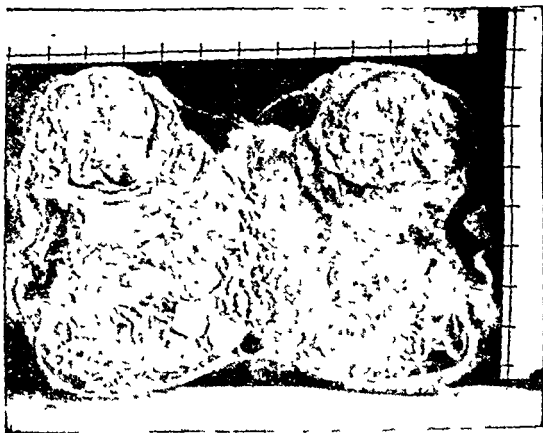


Fig. 3.

Case 1. Same as 2, showing the cut surface.

#### Case 2.

M., male, aged 15 years, farmer by profession, was admitted for a swelling on the lateral aspect of the right thigh, of two months duration on 2-11-45.

Six months ago, while running in a ploughed field, he slipped and fell on his right side. He got up immediately and resumed work without any pain or discomfort.

Four months later, he noticed a swelling on the lateral aspect of the upper part of the right thigh,

which was gradually increasing in size. With increase in size pain appeared, more after walking long distances or working in the fields. Soon after he noticed the swelling, he had an attack of fever lasting two days.

The patient was a moderately well built person. There was a hemispherical swelling in the right trochanteric area, 20 by 20 by 6 cms., woody hard in consistence, with well defined borders except in the posterior and inferior regions. The swelling was not adherent to the skin, but when the femur was moved, the swelling appeared to move with it, but the tumor could also be moved independent of bone, and caused the suspicion of a pedicle. All the systems were normal. The r.b.c., w.b.c., tuberculin test, the sedimentation rate were all within normal limits. Blood calcium was 11 mgms. and blood phosphorous 2.1 mgms. %.

Roentgen examination showed a large shadow completely overlapping the upper end of the femur, and the bone underneath appeared normal. (Fig. 4).



Fig. 4.

Case 2. Roentgenogram showing calcified bursa.

Preoperative diagnosis was doubtful as in the last case, the very large size suggesting a calcifying chondroma, while the very short duration was in favour of a bursal affection. Operation was performed on 8-11-45 under open chloroform narcosis. The tumor was bound down and adherent to the gluteal muscles, which had to be cut in parts to free the tumor, but had no contact with the bone. The greater part of the tumor was cystic and contained a thick gritty material.

Convalescence was normal, and the patient was discharged from the hospital on 24-11-45.

#### Description of Specimen:—

The tumor is roughly kidney shaped. Lateral surface is convex and appears to be lobulated. Medial surface is slightly concave and smooth. It is well encapsulated, 15 by 11 by 6 cms. in size, and weighs 695 grammes. On section the capsule is thick and firmly adherent. Dense greyish fibrous tissue is seen along with numerous islands of varying size consisting of pale yellow homogeneous cheesy material. Several of these have coalesced to form large irregular pale yellow areas. The appearance is not unlike that seen on section of matted caseating lymph glands. The cheesy material is gritty. There appears to have been degeneration of portions of the tumor with subsequent calcification. (Figs. 5 and 6).

The microscopic appearance shows branching fibrous processes, the intervening spaces filled with dark blue masses. The fibrous processes consist of fully formed fibrous tissue, parts of which show hyaline changes. The centres of these contain a core of blood vessels in which red blood corpuscles can be seen. At the margin of some of the fibrous processes are seen fibroblasts, numerous macrophages and foreign body giant cells. Lymphocyte infiltration is also noticed. No definite epithelium is seen to line these fibrous processes. The border appears as a dark blue line made up of particles of the same colour. The intervening spaces between the fibrous processes are filled with dark irregular clumps. These are probably calcareous in nature. There has probably been a degeneration of the lining secreting cells of the bursa, with subsequent calcification, the calcareous particles exciting a macrophage and giant cell response. (Figs. 7 to 9).

#### TREATMENT

If the condition warrants on account of the size and mechanical disability, or due to pain, removal is obviously indicated. Removal gives permanent relief and is simple. Physiotherapeutic measures have been advocated, and may be tried in cases where consent for removal is not forthcoming.

#### SUMMARY

1. The anatomy of bursae round the great trochanter of the femur is described.
2. Two cases of calcification (one of them of unusual size) in the bursa near the great trochanter is described in detail.



Fig. 5.  
Case 2. Showing surface of bursa after removal.

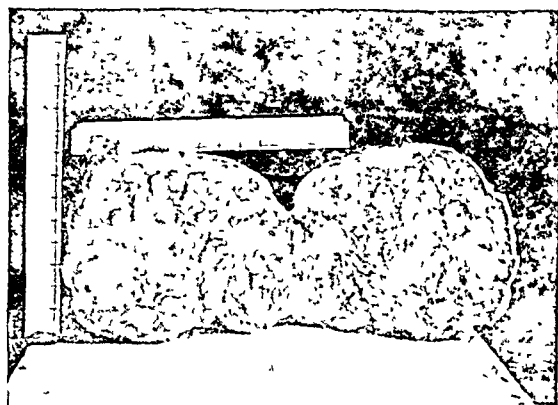


Fig. 6.  
Case 2. Same as 5, showing the cut surface.



Fig. 7.  
Microphotograph showing branching fibrous processes.



Fig. 8.  
Microphotograph showing marginal deposit of calcium—(darker areas).



Fig. 9.  
Microphotograph showing clumps of calcium between fibrous trabeculae.

3. It is suggested that

(a) for calcification, trauma and haemorrhage are not necessary precursors,

(b) calcification and 'local tuberculous diathesis' may be inter-related.

4. Treatment is by removal and gives permanent relief of symptoms.

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# EPITHELIOMA OF THE BUCCAL MUCOSA\*

by K. M. RAI.

In this discussion I propose to include carcinomas of the lip as well, as very often one leads to the other and their histological characteristics are also identical.

Cancer of the lip and cheek is a definite clinical entity. It accounts for about 10 per cent of all intra-oral neoplasms. It is a disease of the elderly and old patients and

cers. About 88% of all the cases occurred in the age group 30—60 years; the sex incidence in the above series is about 75 per cent in men and 25 per cent in women whereas in the Western countries the incidence is 85% and 15%. The majority of tumours are squamous-celled carcinomata, and the degree of differentiation shows variations similar to those in the tongue and

## DURATION

1. M.	2. M.	3. M.	4. M.	5. M.	6. M.	7. M.	8. M.	9. M.	10. M.	11. M.	12. M.	Over 1 year	No. Notes	Total
36	67	73	62	19	70	11	22	7	13	7	56	29	261	733
	14.2%	15.5%			14.8%									

Males	Females	Total	Higher Class Middle Class	Poor	Total
545	188	733	74	659	733
74.35%	25.65%		10.1%	89.9%	

## SITE

R. C.	L. C.	Cheek	Right Lower lip	L. L. L.	R. L. L.	L. U. L.	Lip.
261	332	643	23	60	3	4	90
40.6%	59.4%		25.6%	66.7%	3.3%	4.4%	
							Total 733

## AGE GROUP

1-10	11-20	21-30	31-40	41-50	51-60	34	71-80	Total
1	1	43	182	289	177	61-70	6	733
			24.8%	39.4%	24.15%			

## GLANDS

No palpable glands	Glands present not fixed	Glands fixed	Total
161	151	421	733
22%	20.5%	57.5%	

in my series of 733 cases a large percentage occurred in the fifth decade of life, on an average, about 10 years earlier than in the Westerners. This age incidence is in conformity with the occurrence of other can-

the rest of the mouth from the keratinizing to the anaplastic type. Some of these tumours originate from the mucous secreting glands of the cheek and these form the small minority of adenocarcinomata. Benign tumours are rare and are most commonly

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met with in association with similar tumours of the salivary glands and belong to the group of mucous-and-salivary gland tumours.

Sarcoma sometimes occurs in the substance of the cheek and involves the buccal mucosa; generally it is of the small round-cell variety, extremely malignant, and gives rise to rapid visceral dissemination. It occurs in young patients and the sex incidence is said to be equal. The disease has been recorded in the literature on several occasions. In my own series there was only one case which occurred in a young girl of 8 years of age. It responded rapidly to irradiation treatment and so did the cervical glands. Within a few months wide spread metastases occurred.

The macroscopic types fall into the three common groups; papillary, ulcerative and nodular. Adenocarcinomata are nearly always of the nodular type. The lesions in the buccal mucosa seem to be closely related to precancerous conditions such as leukoplakia, and chronic irritation from sharp carious teeth, heat or chemicals such as tobacco and lime as in the betel-nut chewers of the west coast of Madras Presidency.

On examination of these cases the buccal mucosa is found to be redder than normal, slightly velvety in places, uneven, and sometimes rough; the smooth shiny appearance is lost, and the areas affected are dry.

Histological examination of small pieces removed from these patches of altered mucous membrane shows an increase in the thickness of the epithelium and marked downgrowth of epithelial columns, features similar to those found in leukoplakia elsewhere in the mouth. Leucoplakia of the thin mother-of-pearl type in patches or streaks is seen in the rest of the mouth. Eventually these develop into an epithelioma and when the lesion is fully developed it infiltrates the substance of the cheek and in advanced cases many of them perforate externally.

The lesion may begin anywhere in the buccal mucosa, either in the upper or lower

gingival sulcus and spread to the centre or may start in the lips and spread to the cheeks or vice versa; the commonest site, however, is the centre of the cheek at a level opposite the upper and lower molar teeth. The early symptoms caused by the lesion may be some discomfort, to which the patient with a precancerous mucous membrane is accustomed to and takes no notice. The commonest history one gets is that there was some tooth ache which was not taken notice of. When ulceration occurs the lesion becomes infected, and pain and some restriction in opening the mouth follow. The papillary type presents a typical appearance, the warty growth being as a rule dead white, in marked contrast to the remainder of the buccal mucous membrane. On bidigital examination the substance of the cheek is felt to be thicker and harder than on the opposite side. Invasion of bone more often of the lower jaw, is found in the extensive ulcerative type of lesion untreated or inadequately treated by minor surgical interference or in failures following radiation treatment. A peculiar feature in the incidence of this disease is that it predominantly occurs on the left side whether it be the cheek or the lip. On the cheek it is 60% on the left side. Do most people eat on the left? Another interesting feature is that the incidence in the middle and upper classes is comparatively very much less. In the above series it is 10% as against 90% in the poorer classes. I am convinced that social and economic conditions do play a great part in the incidence of this disease.

In my series of 733 cases, invasion of the cervical lymphatic glands occurred in 78% cases. Of these in only 20.5%, the glands were not fixed. The incidence of glandular involvement from the cheek is greater than in the case of the lip but smaller than in the case of the tongue.

The distribution of the metastases in the neck is somewhat different from that in the case of lesions of the tongue. The submaxillary and the upper deep cervical glands are more frequently affected in the case of cheek and the submental in the case

of the lips and this has a bearing on the extent and nature of treatment of the glandular area.

### DIAGNOSIS

Diagnosis of the neoplasms of the buccal mucosa is generally based on the clinical appearance of the lesion. If the neoplasm is of the papillary type the clinical differentiation between benign and malignant papillomata is sometimes difficult or impossible; in the ulcerative type the differential diagnosis between chronic, simple or specific lesions and a malignant ulcer is based on the hardness on palpation, the type of the edge and the appearance of the base of the ulcer. In the nodular variety differentiation from benign tumours is difficult. In all cases where there is a doubt it is essential that the patients should be submitted to a biopsy. In the presence of leucoplakia in certain number of cases repeated biopsies may be necessary and there should be no hesitation to do this as after all, this method of diagnosis is the least likely to waste time,—the time factor being the most important single factor in the prognosis of a malignant growth. At the same time the histological finding provides a very valuable guide to the differential diagnosis of the various types of tumours, and is a step in assessing the prognosis and the chances of glandular involvement.

### METHODS OF TREATMENT

Surgical excision as usually practised consists in the removal of the tumour through the mouth in early cases or together with the skin and the whole thickness of the cheek in more advanced cases followed by some form of plastic operation. The results of surgical treatment are said to be comparatively good if the excision is wide. Mutilation is greater than from irradiation and functional disability is at times very marked. As the tumours at this site are squamous-celled carcinomata in the majority of cases and respond well to irradiation, in my opinion as also in the opinion of other Radiotherapists, the results of radiation

therapy justify its selection as the method of choice. Surgical excision of these lesions has been almost entirely given up in our hospital.

The methods of irradiation depend upon the size and depth of the lesion and can be subdivided into five main groups (1) Intra-oral surface irradiation by radium; (2) Interstitial irradiation by radium; (3) External surface irradiation either by X-rays or radium; (4) low voltage short distance X-radiation (-Chaoul) or (5) A combination of intra-oral and external irradiation.

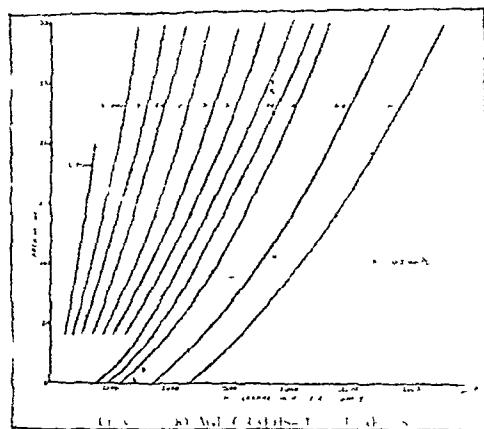
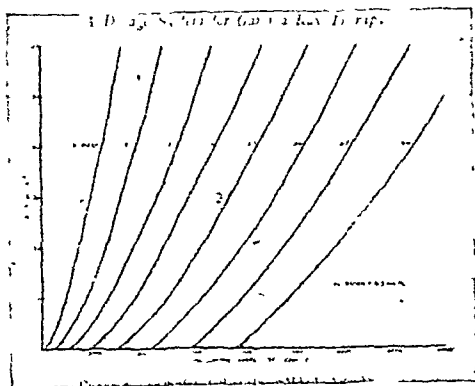
### TECHNIQUE OF RADIUM TREATMENT

Intra-oral surface radiation with radium—For a localised growth not invading the muscles or the gingival mucosa, surface irradiation from within the mouth is a simple method, it has the advantage that it requires no anaesthetic and no operative procedure. Preliminary oral toilet and extraction of teeth should be scrupulously carried out in every case. A week or 10 days spent in clearing oral sepsis is certain to pay a good dividend in the end. It should be clearly understood that sepsis and heavy irradiation never go well together. The condition of sepsis and oedema of the tissues bring on a state of anaerobiosis which is inimical to the success of irradiation. Even in the advanced cases where any form of therapy is of doubtful value steps taken to eradicate sepsis is of much palliative value. Therefore, these measures are a routine practice with me. A stent impression is then taken of the cheek to be treated, including the lesion, the palate, and alveolus of the upper and lower jaws. This shield fits in between the alveoli and the cheek, and its outer surface is in contact with the neoplasm. At a suitable depth usually 1 cm. from the outer surface of the denture the radium needles are embedded according to plan.

This apparatus provides surface irradiation at a distance of 1 cm. from the surface of the lesion. If success from radium treat-

ment should be attained every meticulous care should be taken with regard to the correct planning of treatment and details of its execution. The least error in the execution of these details of technique is as disastrous here as in surgery in relation to the final results. As in surgery, so in radiotherapy the first chance is the best chance and if this is missed by an error in the tech-

being 12 to 14 hours daily. Most patients tolerate this fairly well, provided the whole treatment is finished in 8 to 10 days. Thereafter the treatment becomes more difficult as the reaction begins to start and the wearing of the temporary denture becomes uncomfortable. The greatest amount of radiation is no doubt received on the surface of the tumour and the least on the skin but the



Figs. 2 and 3.

Paterson and Parker's Dosage graphs for Surface Irradiation at different distances. The abscissae read the Milligramme-Hours per 1000r and the ordinates the area in sq. cms.

nique or dosage then nothing but calamity overtakes the patient. It has been conclusively proved beyond doubt that the rate of 5-year cure falls from 85% to 11% with regard to recurrence. Our technique for surface irradiation with radium is a system evolved out of the methods employed at the Royal Cancer Hospital, London and the Holt Radium Institute, Manchester. The technique adopted in treating a lesion is as follows. The lesion is first measured including a safe margin of apparently healthy area round the lesion. The appropriate quantity of radium to deliver the lethal tumour dose is then decided upon from the relevant charts. The next step is to determine the distribution of this selected quantity of radium according to certain physical principles so as to ensure a homogenous distribution of radiation throughout the tumour and its bed. After this is done, the irradiation is given intermittently, the average time

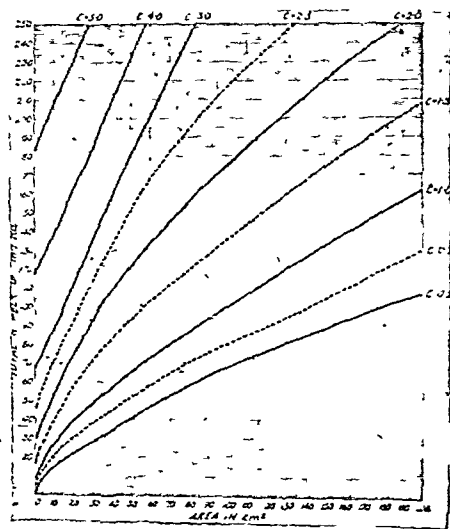


Fig. 4.

Mayenord's graph for determining the adequate quantity of radium to be used.

aim is to give about 6000r to the tumour. If this has not been possible, then supplementary radiation is given from outside either by means of radium in a sorbo-rubber pad or by deep X-ray therapy. The typical reaction that one obtains in such a case is a thin whitish membrane with red margins; this membrane becomes thicker and yellowish tention of fibrinogen, etc. and continues to be in colour in about a week due to the forma-

so for the next 8 or 10 days and then begins to get thinner and thinner until it finally disappears in about 4 to 6 weeks leaving a reddish, healthy area. Any attempt at removal of this membrane results in bleeding and the membrane again reforms quickly. Protection to the rest of the mouth from stray radiations is obtained by the incorporation of suitable thickness of lead foils on the oral side of the mould.

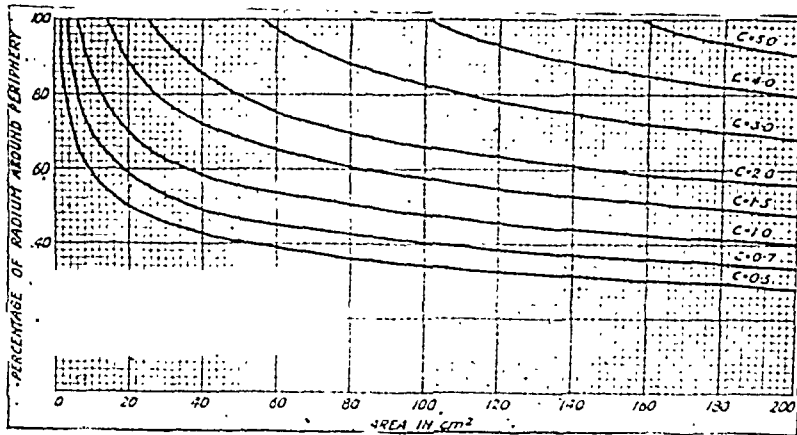


Fig. 5.

Dr. Mayenord's graph shows the quantity of radium to be distributed along the periphery.

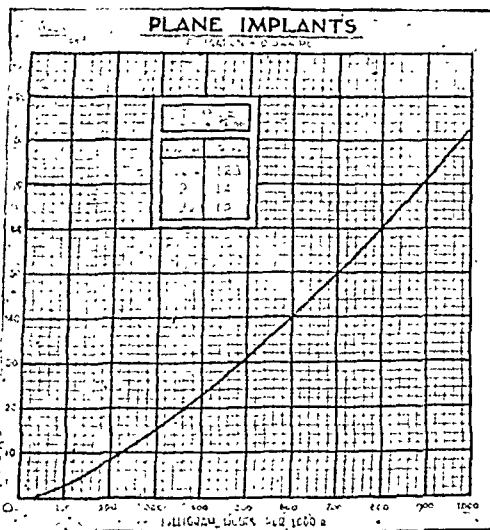


Fig. 6.

Paterson and Parker's graph for Plane Implant Dosage. The abscissae gives the Milligramme-Hours per 1000r and the ordinates the area in sq. cms.

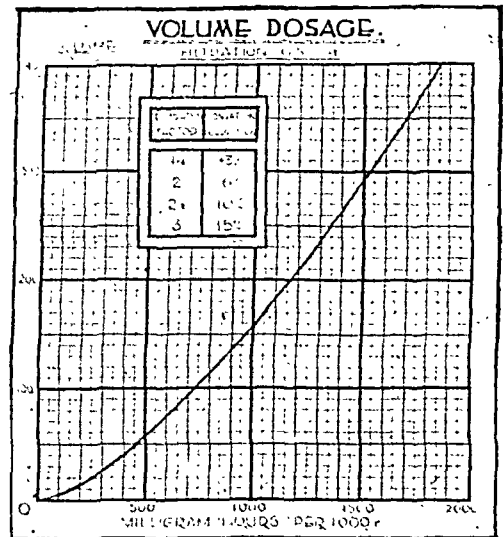


Fig. 7.

Paterson and Parker's graph for volume implant dosage. The abscissae gives the Milligramme-Hours per 1000r and the ordinates the volume in cubic cms.

### INTERSTITIAL IRRADIATION

This is no doubt the quickest method and a total dose of 6000 to 8000r can be given in a week with small quantities of radium such as 10 or 20 mgm. The lesion in the buccal mucosa is particularly suitable for this method, as in the majority of cases a one plane implantation is sufficient and the lesion can be very accurately treated. The needles are placed in a plane parallel and deep to the lesion according to plan, the area treated in all cases being larger than the actual tumour. The number of needles depends on the size of the tumour and is calculated with the aid of different charts.

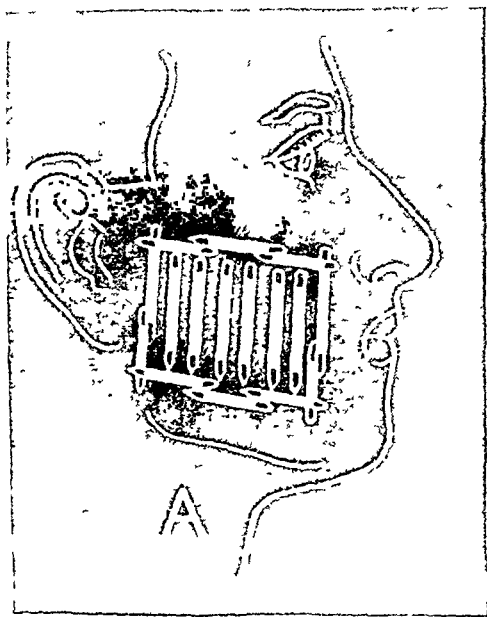


Fig 8.

Example of a Plane implant in the cheek  
(After Paterson and Parker)

If the needles are placed in pairs from opposite directions and tied they need not be sutured in and are easily kept in position for the necessary time; otherwise special care should be taken to anchor each needle separately; the total time of interstitial radiation varies from about 120 to 192 hours

on an average. In lesions involving the deeper aspects of the skin a combination of interstitial needling and an external surface irradiation is indicated.

The following case, more advanced than the type mentioned illustrates the result of this method:

Male aged 66 a University Professor was treated by me by needling, first from inside the mouth, then external irradiation with deep X-ray therapy. The lesion was an extensive and inoperable ulcer of the right cheek which had envolved the jaw, perforated through the skin, and formed numerous sinuses. Biopsy—squamous called carcinoma with hardly any keratinization. The dose as measured in the centre of the tumour by this combined method was in the neighbourhood of 7000r. The condition resolved satisfactorily leaving two sinuses and an osteomyelitis of the lower jaw. The patient also improved in general health, but died 18 months later. (Fig. 9.)



Fig. 9.

### EXTERNAL SURFACE IRRADIATION

External surface irradiation of lesions of the buccal mucosa can be employed as the sole method of treatment, but it is not a practical method, as the reaction of the skin limits its application except in the case of the lips. In combination with the interstitial method it is a useful additional treatment and should be carried out in cases where the skin is involved. It is a simple

method of irradiation, requiring about 30 to 40 mgms. of radium. A sorbo-rubber plaque of 2 c.m. thick is generally used as a support to which are attached the required number of needles of radium. The needles are arranged in squares or circles or some other geometrical figures to ensure homogenous distribution of radiation in the area under treatment. The area irradiated should exceed in all directions the extent of the lesion. As an alternative to the above, I invariably use deep X-ray therapy which is much simpler and easier to carry out.

No case of epithelioma of the cheek can however be treated effectively with either deep X-ray therapy or teleradium alone without at the same time producing a membranous reaction on the side of the tongue, the gums and the palate. The additional discomfort is sometimes considerable; the extent of the reaction and the length of time required for the treatment are drawbacks which should be taken into consideration.

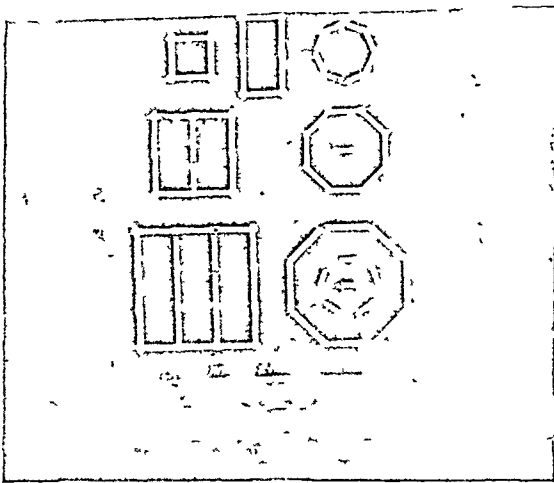


Fig. 10.

Diagrams of typical geometrical distribution of needles for homogeneity of dosage.  
(After Paterson and Parker)

### LOW VOLTAGE X-RADIATION

In early lesions the low voltage short distance X-radiation otherwise known as Chaoul therapy is the ideal method which requires no hospitalization, is rapid and accurate and the results are as good as any

and in properly selected cases has many advantages over any of the methods described hitherto. There are certain well-defined principles which should be scrupulously observed in this method, failing which the results may be disastrous. That is why one hears of conflicting reports regarding the efficacy or usefulness of this method of treatment. If all the principles of the technique, its limitations, etc. are understood it is as efficacious as radium in its results, far more accurate, more easily carried out, less troublesome for the patient, takes only a few minutes every day and last but not the least important—the patient does not require hospitalization; where necessary this can be combined with deep X-ray therapy to get the required dose and its homogenous distribution:

Illustrative cases—

(a) only with Chaoul.

(b) Chaoul and deep X-ray combined.

Mr. B. aged 61 years reported for treatment on 2-10-1940 with a history of two

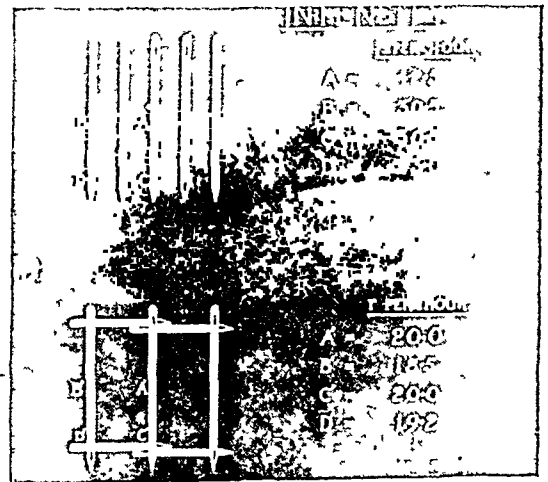


Fig. 11.

This illustrates importance of proper geometrical distribution. The affect of variation in intensity at 1 cm. due to different arrangements is shown. (After Paterson and Parker)

months. He had an epithelioma of the left cheek and gums of the lower jaw extending as far as the canine tooth; no evidence of secondary glands.

A dose of 6000r was given to the whole lesion in 15 sittings through 5 fields ending on 19-10-1940. The lesion healed well. The patient again reported for examination on 5-8-1941 and on examination it was found that the original ulcer was well healed leaving a soft supple scar. But posterior to this scar, there was a small ulcer about the size of a two anna silver coin with hard indurated base covered with a greyish white slough. Biopsy proved it to be a recurrence. This was again treated with chaoul therapy and the patient is alive and well upto date with no secondary glands.

Mrs. K. P. aged 55 years, reported on 13-12-1943 and treated by me first from inside the mouth with Chaoul contact X-ray therapy and then by external irradiation with deep X-ray therapy at 150 kv. to obtain the required homogenous radiation throughout the tumour area.

The lesion was a hard raised plaque 3.5 c.m. in diameter over the left cheek, situated opposite the 2nd premolar and first 2 molars infiltrating the deeper tissues but not involving the skin. No palpable glands in the neck or submaxillary region, were present.

Duration — 6 weeks.

After preliminary attention to the dental condition, a total of 6000r was given to the lesion in 16 sittings over a period of three weeks. This was followed by external X-ray therapy at 150 kv. at 200r per sitting and a total 2000r was given over 11 days.

The patient is alive and well to date. No secondary glands have appeared so far.

Mr. C-J-W., aged 80 years. Referred on 28-8-1939 and treated. This patient had an epithelioma of the right lower lip outer third—involving the whole thickness of the lip—of eight months' duration. No palpable glands either in the submental or sub-maxillary region. The thickness of the lesion was 2 c.m. The condition was treated with Chaoul therapy by two fields sandwiching the area and a total dose of 6400r was given in 16 sittings over a period of 18 days.

The condition completely healed leaving a soft supple scar. The patient is alive and well with no metastases after 8 years. (Fig. 12.)

### MULTICENTRIC EPITHELIOMATA. OF THE BUCCAL MUCOSA

The condition is sometimes met with and is either precancerous or definitely epitheliomatous. It is characterised by the superficial spread of the lesion over a wide area with little tendency to penetration into or involvement of the submucosal tissues. The main characteristic is its chronicity. A history of 18 months to 2 years is usual. Clinically it differs from leucoplakia. As a rule the white patches are absent. It occurs most frequently at the junction of the hard and soft palate, spreads to the uvula, the

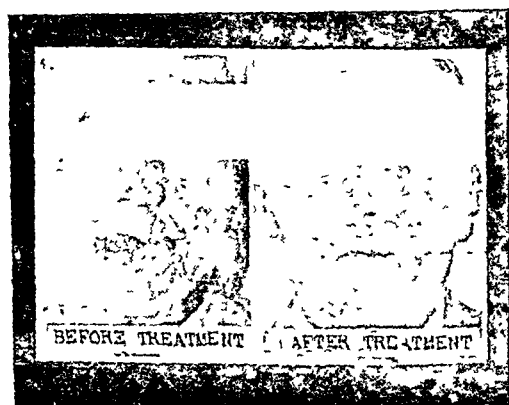


Fig. 12.

pillars of the fauces, the alveolar mucous membrane, and the sulci between the cheek and gum and even to the vermillion part of the lips.

The lesion is a superficial ulceration surrounded by an erythematous zone; small papillary masses are scattered at the edges of the lesion. The remainder of the mucous membrane is atrophic. The symptoms are those of chronic superficial ulcerations, discomfort, slight pain, loss of taste, a sensation of pricking and burning, and dryness of the mouth. Malignant changes take place in one part, the remainder not undergoing such a change for sometime but as the condition is precancerous, any area may

become malignant, and give rise to multicentric lesions.

Secondary deposits occur in the glandular areas inspite of the apparently superficial character of the growth. The glandular involvement is localised and the prognosis is moderately good.

The superficial nature of the lesion and the marked degree of radiosensitivity make it a suitable type for radiation treatment; and perfect healing of the superficial ulcers with arrest of the hyperplasia can easily be obtained. I prefer Chaoul's therapy to radium for the primary lesion.

### ILLUSTRATIVE CASE

Mr. U. A. aged 32 years reported on 18-5-1939 with an epithelioma of the left cheek opposite the molars of 3 months' duration and a wide distribution of leukoplakic patches all over the buccal mucosa. This malignant portion of the lesion alone was treated with Chaoul therapy with complete healing. A complete dental extraction was done after this treatment and supplemented by suitable medical measures. The patient is alive and well after over 8 years.

### METASTASIS IN CERVICAL LYMPHATIC GLANDS

The field of lymphatic spread from the mouth must be considered as extending from the highest to the lowermost levels of the neck. Obliteration of the normal lymphatic vessels by active malignant disease, fibrosis or surgical removal diverts the lymphatic stream into new channels, so that further extension by direct spread or embolism takes place in anomalous site. The rapidity of dissemination and the susceptibility of the glands to metastasis varies in direct proportion to the degree of anaplasia of the growth.

The appearance of palpable glands in the neck may be early or late. The late development of secondary deposits in the cervical glands long after the disappearance of the primary growth in the mouth show that there is a period of latency which may last

many months to years during which clinical methods of examination cannot reveal the presence of malignant cervical deposits. The marked failures of incomplete operations for the removal of the cervical glands, the hopelessness of cases where the glands are inoperable, and the death of patients from cervical deposits although the primary lesion remains healed are convincing proofs of the importance of early and adequate treatment. The problem presented by all these cases is to determine the best way of dealing with these.

An answer to this raises several problems:

1. Does absence of palpable glands offer absolute indication of freedom from disease?
2. Are all enlarged glands necessarily malignant?
3. What is the role of surgery and irradiation individually and in combination in the treatment of
  - (a) cases where regional glands are not palpable,
  - (b) cases where they are palpable but are operable,
  - (c) cases where they are palpable but are inoperable.

Absence of palpable glands does not necessarily mean that metastasis has not occurred. In a number of cases the primary lesion was completely cured and remained cured; no palpable glands were detected in the neck for several months to years after the disappearance of the primary and then they developed rapidly.

It does not always mean that an enlarged gland is due to malignant infiltration. Some of them are enlarged as a reaction to septic absorption from the oral cavity and this has been repeatedly confirmed histologically.

The factors that influence the choice of the line of treatment,—surgery or irradiation or a combination of these two—are

- A. Site of the primary lesion, its extent and the length of the history.



B. Histological features of the primary growth.

C. The clinical condition of the lymphatic glands.

And to these should be added the condition of the patient—his general health and age.

#### A. SITE

*The lip.*—In carcinoma of the lip the development of secondary deposits in the cervical lymphatic glands is exceptional unless it is advanced. Most authors report that on an average 80% of cases do not develop metastases. The earlier the lesion the better the prognosis; in advanced cases the glands are either affected when the patient first seeks treatment or develop subsequently. In the case of the lip I am of the opinion that in the absence of enlargement no treatment of the glands either by surgery or radiation is indicated. If the primary lesion responds well to the treatment and disappears completely, the neck can be safely left untreated provided adequate periodical supervision is carried out. Should the glands enlarge subsequently, immediate treatment is indicated.

*The buccal mucosa.*—The incidence of glandular involvement from a neoplasm of the buccal mucous membrane is greater than in the case of the lip; most statistical tables give the incidence as 50 per cent of the total early cases. If the lesion is left untreated for a prolonged period the glands will become affected in most if not all cases but the development of metastasis is never as widespread as in the case of the floor of the mouth or the tongue or the palate. The lymphatic drainage is more limited and at first restricted to the submental and submaxillary glands, and in some cases to the pre-auricular gland, then to the upper deep cervical glands. An operation limited to these areas may be permissible, in contradistinction to the full block dissection but operation and irradiation both pre- and post-operative, should be the method of choice in these cases as they are more certain of positive results. Irradiation alone is

not the method of choice in these cases and should be used only if operation is contra-indicated.

#### B. HISTOLOGICAL VARIETY OF THE PRIMARY GROWTH

The natural history and the course of the disease depend largely on the histological variety, of the primary growth. The prognosis as regards liability to lymphatic metastasis and hence the ultimate prognosis depends eventually on the structure of the tumour. In the choice of treatment of the lymphatic field the histological variety should therefore influence both the selection of treatment and the prognosis. It is recognised that the most malignant, anaplastic undifferentiated growths are prone to early lymphatic dissemination, and as these lesions are in the majority of cases radio-sensitive the first step in the treatment should be radio-therapeutic measures—X-rays or Radium. If irradiation causes complete disappearance of the enlarged glands no further treatment is indicated. Repetition of the treatment remains a separate problem for each individual case. If irradiation does not cause complete regression of the glands, operation must be undertaken without delay.

Post-operative irradiation is indicated if the disease has not been adequately dealt with by the operation as also in anaplastic lesions. In the case of the transitional type or the keratinizing variety, operative removal would give better results in the majority of cases and should be the method of choice, provided a very complete and wide dissection can be carried out.

Irradiation is the method of choice in the undifferentiated type of carcinoma; and is the only justifiable method in sarcoma. Surgery will always be safer if pre-operative irradiation in small doses (not exceeding 2000r to the skin) is given. The results of surgical treatment can be improved by pre and post-operative irradiation in most cases. The results of irradiation can be sometimes improved by surgical excision in selected cases of anaplastic but radio-resistant neoplasms,

### C. THE STATE OF THE GLANDS

Difficulties occur in the selection of treatment in various stages of the disease. All cases of cancer of the mouth fall into one of the following three groups (1) where no glands are palpable on clinical examination (2) where enlarged but movable glands are present (3) where the glands are fixed, on the borderline of operability or frankly inoperable.

1. *Where the glands are not palpable.*—The most difficult problem is in the case of a patient with no palpable glands in the neck. Opinions differ very widely as to the best course to be adopted. The possibilities open to the surgeon are as follows: (a) No active treatment—the patient to be kept under continuous observation and the development of glands awaited before any treatment is given. (b) Irradiation by X-rays or Radium as a prophylactic measure. (c) A block dissection to be carried out in every case. The problem is of such great practical importance that a detailed consideration of each of these possibilities is indicated.

(a) A policy of 'watch' without active treatment—This course is advised by some authorities particularly the Manchester school and I fully agree with this view if the patient will intelligently co-operate with you. If this is doubtful and the general health of the patient warrants and there is a reasonable chance of a permanent cure of the primary lesion—then operate. But it is difficult to persuade a majority of such patients. Therefore we have been sometimes able to reverse the sequence of treatments, i.e. first do a block dissection and then treat the primary. How far this is a justifiable, I am not in a position to state.

(b) The so-called 'prophylactic irradiation'—this method of treatment has been tried very widely. I have given this method a good trial and have discarded this method as disappointing in results and unsound and unscientific. It should be accepted that such an irradiation presumes the presence of malignant infiltration of the cervical glands, so that nothing short of a full-lethal dose is

likely to arrest the disease. If this presumption is correct, although a clinical examination does not reveal any abnormality in the neck, the word prophylactic is a misnomer, as the irradiation has for its object, not the prevention of metastasis, but the destruction of already existing malignant cells, however small in number or however silent clinically. A review of all the available literature leads to the following conclusions. So-called prophylactic irradiation of an apparently normal neck is not justifiable; it does not prevent the ultimate development of secondary deposits in the cervical glands; it is at times distinctly harmful as it renders subsequent treatment by radiation when metastases occur and when radiation is urgently needed, more difficult and less effective and sometimes impossible owing to the changes in the skin, subcutaneous tissues, and vessels. It also considerably increases the difficulties and risks of any subsequent surgical operation on the cervical glands due to the above changes.

(c) Prophylactic block dissection—This is not done in our hospital and I am not in favour of it either for reasons already given.

2. *Where the glands are palpable but movable.*—In this group treatment is obviously essential, and the selection of treatment lies between surgical excision and radiological treatment. Having tried radiation as the sole method of treatment, I have come to the conclusion that today wide surgical excision gives better results. It matters little how the radiological treatment is given; if safety from recurrence is the first consideration surgical excision offers more than any form of irradiation.

But it should be clearly understood that teluradium, X-radiation, or interstitial radium can arrest the disease completely in a certain number of cases, but the results of the treatment cannot be forecast. Surgical excision in operable cases gives an assurance that the whole lymphatic area has been removed but irradiation gives no such assurance. As the patient's life depends upon the result of the first treatment and if a case is suitable for radical surgery then

this should be made clear to the patient, and radiation should not be offered as "equally good."

Although surgery is unquestionably the best form of therapy it is not applicable to all cases, and success or failure depends upon careful selection of cases and faultless surgical technique. Knowledge of the disease, sound judgment in estimating the prognosis of the primary growth, clinical acumen in the correct interpretation of the extent and operability of the glands in the neck, are essential in the selection of cases. The following conditions should be satisfied in every case :

(a) The primary growth must be healed, and there must be a reasonable prospect of permanent cure.

(b) The histological picture of the primary must be of the type of Broder's group I or II.

(c) The glands, although palpable and clinically malignant should be mobile or only slightly adherent.

(d) The general health of the patient should not preclude a major operation.

If the above conditions prevail a block dissection should be carried out. It is perhaps not understood by a fair number of radiotherapists or surgeons what is meant by a block dissection. Judging from the limited skin incision in several of the cases labelled as 'block dissection' no such operation could have been carried out. The principles of the operation are the wide excision of the deep cervical fascia from the level of the jaw and styloid process to the level of the clavicle over an area covering the anterior and posterior triangles of the neck; with the fasciae are removed the fat and the whole of the glandular chain and this cannot be done adequately without removal of the sternomastoid muscle and

The value of pre- and post-operative irradiation of the neck has been much debated. My opinion is that pre-operative radiation renders the operation safer; the chances of disseminating the disease by the

surgical act are thereby lessened; the glands are diminished in size and the operation for their radical removal made more easy. Pre-operative radiation should not lead to a marked skin reaction; a total dose of 2000r to the skin is sufficient. It is a matter of no importance whether radium or X-rays are used. The treatment should in no way delay the operation; radiation of the neck should be followed immediately by operation without any intervening period. I generally give this dose in about 10 days and advise the operation immediately after. I have consistently followed this practice in cancers of the breast with very encouraging results.

A course of preoperative irradiation for cases on the borderline between operable and inoperable states is definitely indicated. In the majority of cases these inoperable lesions become operable after a certain period after the cessation of the irradiation therapy. The dose in such cases is higher, than in the previous instance. But I should add a word of caution, i.e. the operative procedure should be deferred till the tissue reaction completely passes off.

Post-operative irradiation is indicated only if the histological examination of the glands shows a secondary deposit. Post-operative irradiation by X-rays is as efficacious as by radium; it is preferable to radium as it is more simple. Post-operative irradiation should be given in about 3 to 4 weeks after operation, when the wound is soundly healed.

Radiation therapy in operable cases: In cases unsuitable for surgical excision, radiation should be given. If the glands are palpable, radium is said to give better results than X-rays, except in the anaplastic type, where X-rays are equally good but a combination of both radium and X-rays presents certain advantages, as this enables the radiotherapist to deliver a larger total dose than either method used to the exclusion of the other.

3. When the glands are fixed and inoperable.—This group of cases includes the advanced stages of the disease, varying from a small, hard, fixed mass of glands to diffuse

swelling of the side of the neck. Opinions are unanimous that attempts of surgical removal are contra-indicated. The chances of cure by surgery in this type of cases are remote, the danger of incomplete removal very real, and radiation therapy offers a means of palliation unparalleled by any other method of treatment.

The radiological treatment consists in a combination of X-rays and radium. Preliminary external radiation should precede the interstitial treatment which is a supplementary method of increasing the dose in the deeper parts of the mass. This treatment can reduce the tumour very appreciably, and sometimes leads to a total disappearance of the neoplasm.

## CONCLUSIONS

1. The varieties of carcinomata of the Buccal mucosa their diagnosis and treatment are discussed.
2. The techniques in radiation therapy have been discussed.
3. The relative positions of surgery and radiation therapy have been discussed.
4. In conclusion it is stressed that there should be a wholehearted understanding and cooperation between the surgeon and radiotherapist to attain the maximum benefit out of these different procedures if results have to be improved.

## EARLY AMBULATION IN SURGERY\*

by R. KALAMEGHAM and T. V. SUNDARAM, Trichinopoly.

In discussing early ambulation, Steinhart says "with surgical efficiency at its level we should not be satisfied with merely recovery from a surgical operation, but we should know, as Matas once stated how the patient has recovered, to what extent she has been restored to her anatomical and functional integrity and to what extent she has been cured and made fit to return to her normal life and occupation".

In this paper we have tried to put forth some of the ideas on post operative ambulation as practised to-day. The place of physical medicine in surgery has been amply demonstrated by the recent World-War, while this aspect is scarcely known in civilian Hospitals. The integration of the principles of physical medicine in surgery is a new development which has had rather very slow and tardy recognition when recent advances and trends are reviewed.

Enforced bed rest is a violation of the cardinal principles of physiology. Surgeons were hesitant to ambulate their patients inspite of conclusive proofs of its efficacy. This regimen is in wide practice only since 1941.

Surgery is advancing along lines of sound physiological principles. Even as early as 1861 James Hilton in his Hunterian Oration struck a note on physiological and mechanical bed rest in surgery and remarked that surgeons should always remember that Nature always tries to heal the injuries subjected to her tissues.

Recent advances in surgery are along lines to restore early physiology of tissues and not, as of old, in eradication of the pathology only, without any idea of restoring the physiological functions. Early

ambulation helps to an early restoration of the same.

The regimen of speedy rehabilitation is but a variant of early ambulation after surgery which restores the patient to early function and reversal to a state of normal physiological state.

Post-operative ambulation is defined as early rising and walking. Even after its wide practice since 1941, it is a much controversial aspect of surgery but the consensus of opinion is culminating into unchallenged acceptance of this method. Comparative analytical study of bed-resting and ambulant series of patients under controlled circumstances has proved the superiority of this practice.

Ries in 1899 was the first to report early post operative rising. He noticed that his gynaecological patients who rose earlier were strong and had few complications. He was not impressive in America then; but had adherents in the Continent since 1909. In 1941 Daniel L. Lithauer revived American interest by his report on 436 cases treated by this method. He roused enthusiasm among surgeons widely.

The practice had its inception on observations among children and individuals who violated routine bed-resting and insisted on visits to bathroom. Absence of complications in them observed by house staff and nurses provided as it is called "A Seven Day wonder".

We see children seldom keeping to bed after surgery. They toss in bed, strain and cry to the annoyance of the popular bed-rest-minded surgeon and staff. To one's great surprise, wound anomalies due to activity is seldom seen among this age group. The impressions from such post-operative activity seldom suggested the possibility of early post-operative ambulation without from the dreaded hazards.

\*A paper read by the latter at the Second Provincial Conference of the Indian Medical Association held at Coimbatore on 18-10-1947.

Here we may mention a very rare episode of an accidental self-imposed post-operative activity of one of our patients in 1944.

A 35 year old well built individual was operated on for an inguinal hernia under spinal. On the 2nd day he got maniacal unexpectedly and got out of bed and walked all over the place in a state of marked activity. He ambulated himself much to the anxiety and annoyance of all of us. We expected wound disruption and a certain immediate recurrence. It was amazing to note that he healed without any hazard inspite of the fact that he was sent home on the 3rd day due to this mental state. He was said to be fairly active all the days at home till sutures were removed and inspite of all unwarranted ambulation, then never known to us, he healed. He has been coming to us for review and to date he has no recurrence.

In experimental animals, they noticed that strong and sound healing occurred among those that were allowed activity as against those that were kept in enforced rest.

Apprehension of wound disruption and infection appears to be entirely unfounded as these were absent even among those rugged individuals who had got out of bed themselves without any planned guidance under supervision.

The surgical patient requires ambulation very early in the post operative period. Early rising is very essential for restoration of physiology. The time honoured enforced bed rest predisposes to complications to pulmonary, vascular and gastro intestinal systems among several others.

In 1913 Eugene Pool published a report entitled "Systematic Exercises" in post-operative treatment." He elaborated a definite set of exercises for the bed resting patient designed primarily to prevent pooling of venous blood and thus avoid any vascular accidents like phlebothrombosis, embolism, etc. Activity was observed to produce a lot of well being without any low

state of general condition or wasting of muscles. The patients felt fine with a full function of body and mind. Eugene's exercise in the bed was but a fore-runner of modern ambulatory management.

The proponents of early rising, quote the following phenomena.

1. Lowering of all pulmonary complications.
2. Stimulation of circulation without stagnation, due to movement, contributing to absence of vascular stasis.
3. Stimulation of gastro intestinal system with the consequent absence of nausea, vomiting, distension and ileus.
4. General and over-all physiological effect on body and mind—a healthy somato-psychic effect.
5. Speedy convalescence as a result of former.

After operation, due to pain in the incision the breathing is much slower with a marked decrease in the excursion of diaphragm. This facilitates pooling of secretions in the trachro-bronchial tree encouraged by a general low cough reflex present in recumbency. In addition, there is often excessive mucus and broncho-constriction especially after inhalation anaesthesia. All these factors precipitate pulmonary complications. A sitting posture stimulates cough reflex with easy expectoration of secretion.

Lithauser has estimated that the vital capacity of lungs returns to normal in from 2 to 7 days in the early ambulation patients. In the bed-resting group it is 7 to 14 days. In his study of 900 cases, he records an incidence of pulmonary complications in only two. It is indeed remarkable.

According to Newberger, Joseph and Boldt, early ambulation prevents abdominal complications like ileus, nausea and vomiting as mentioned previously. Absence of these spare the wound of all stress and

strains that interfere with sound wound healing. Bowel function is restored early and this stimulates the appetite.

Most of our type of patients find it very uncomfortable to use an urine glass or bed-pan. They are new to these and hence often fail to void urine or motion. If they are allowed to sit up or even squat, which activities they do gently, though with some apprehensions, they succeed. Catheterisation is seldom necessary and this means less strain to the staff and above all the prevention of the hazards of catheterisation to the genito-urinary tract. There is a slowing of circulation in the bed-resting patient with chances for thrombosis. The working of muscles stimulates circulation with remote chances for vascular accidents incidental to dorsal recumbency. In a shocked patient the often common after extensive procedures on chest or abdomen with haemoconcentration, all contributing to a vascular catastrophe. Such patients should be ambulated gradually as soon as they tide over the shock emergency. If they are not fit for ambulation bed exercises should be instituted.

A New York Hospital bulletin says that as many people die of pulmonary embolism as of cancer of stomach and bacterial endocarditis.

Smith and Allen say that early exercise prevents venous pooling. Frykolm remarks that venous thrombosis is common in planar veins, veins of calf muscles, branches of deep femoral and pelvic visceral veins. He believes that blood vessels collapse in bed resting and shock with intimal contact which favours intravascular clotting in the presence of haemocentration, increased viscosity, and slow circulation.

A short account of statistical and comparative reports of early ambulated cases from various authors is worth mentioning.

One of the very famous proponents and authors of this Technique is Daniel L. Lithauser. He revolutionised the conception in the care of the post-operative patient. But for his pioneer work in this

branch of surgery the time-honoured conservative, unphysiological routine of bed-resting will be in vogue everywhere with all its attendant morbidity and mortality after major surgery.

In Lithauser's study of 900 major abdominal cases, the average discharge rate was 4 days. In an average of 2—5 days he has discharged appendix cases.

Rickles sends most of his cases home on the 3rd post operative day.

In Peter Bent Brigham Hospital in North America they studied a series of ambulant cases in as similar circumstances as possible enabling a scientific appraisal of end results. They practised early rising in 238 cases with 443 cases in dorsal recumbency. The operations were major ones on small and large bowel per lower abdominal incisions. Biliary, gastric and spleen surgery were done per upper abdominal incisions. They used interrupted cotton for all layers except for peritoneum which was closed by chromic catgut.

In the ambulated the results observed were as follows:—

1. Early regaining of strength.
2. No loss of strength.
3. Patients are active in bed with seemingly no - discomfort in wound.
4. They were observed to get out of bed without assistance.
5. Very little nursing-care was needed.

64% of the early risers were discharged on the 13th post-operative day while only 26% of the control group could be discharged by that time.

They classified early risers into 1st day and 2nd day risers.

The following percentage of complications were observed in 1st day risers.

Pulmonary	4.9%
Wound disruption	1.1%

Wound infection	2.7%
Phlebitis	3.2%
Atelectasis	4.3%

## 2nd day risers.

Pulmonary	7.5%
Wound disruption	1.8%
Wound Infection	Nil
Phlebitis	1.8%
Atelectasis	5.7%

## In non-early risers of 443 patients.

Pulmonary	7.9%
Wound disruption	2.8%
Wound Infection	5.7%
Phlebitis	1.8%
Atelectasis	6.3%

In this study there is a higher incidence of phlebitis in very early risers. It is not so in many other's experiences. They conclude that early rising alone does not abolish phlebitis.

Steinhart's major gynaecological cases require 8.72 hospital days in early ambulated as against 13.94 days of late cases.

Cutter in 1941 remarked after a statistical study that 4.5% of all surgical patients develop pulmonary complications while some others believe that 10 to 20% of such patients develop pulmonary hazards.

With recent advances in the dictates of surgical principles and technique, with a focussing of attention on creation of "Good Risk" patients, with newer pre-operative care, undue apprehension of harmful effects of ambulation should disappear.

Hypoproteinaemia should be completely excluded in these cases. This state of blood chemistry favours wound disruption and delay in healing. The following abnormality exists in protein poor patients.

1. There is an aberrant function of the stoma after gastro enterostomy.

2. The Liver of these patients tolerate anaesthesia very badly.

3. The gastric function and motility are enormously upset.

The nitrogenous breakdown and catabolism after operations warrants the existence of the proper protein status of blood.

Early ambulation for obvious reasons should not be thought of in hypoproteinaemic patients.

A state of positive nitrogen tissue-blood balance exists if 0.30 gram of Nitrogenous material is given per Kg. of body weight per day with not less than 30 calories of carbohydrate supply per Kg. per day. The appreciation of physiology of dehydration, electrolyte imbalance, and hypoproteinaemia enables the correct institution of tion better than excess of salt or water.

Avitamoiosis especially of Ascorbic acid delays wound healing.

A careful selection of non-absorbable suture material and strain free transverse incisions are necessary in these cases. Lithauer uses transverse incisions and non-absorbable suture. He has been using steel wire sutures too. Homer L. Skinner prefers thin silk sutures after a study of 1126 cases of hernia.

The current trend of incisions is in favour of transverse ones in which plane stress is very negligible during ambulatory activity.

With these incisions post-operative comfort of ambulant patients is very great. Activities like getting up, retching, cough and movement, instead of tearing apart wound edges actually bring them in close alignment. Hence the value of these incisions in ambulant patients as defined by the proponents of this technique. The sound surgical work ensuring perfect haemostasis, least massing of tissue in ligature and perfect closure of wound in anatomical layers in "Good risk" patients will have negligible complications in this method of recent revolutionary post-operative management. Type of suture employed should be of the non-absorbable variety though it is not a main consideration according to Skinner.

Peritonitis, haemorrhage, shock, anaemia and heart failure are some of the major contra-indications to this procedure.

A modern surgeon has at his command a wide armamentarium in amino-acids,



plasma, chemotherapeutics and antibiotics with which to manage his cases, that there should be very little challenge for this recent advance in post-surgical care. If a patient is got out of bed after the 1st 24 to 36 hours it is not early ambulation at all. Ambulation should be started within 1st 24 hours. It is said that 50% of complications start in the 1st 24 hours after surgery. By the end of 48 hours it increases to 75% and by the end of 4 days it increases to 90%.

In this paper we are not giving an account of any voluminous experience in post-operative ambulation. In limitations of private work we could try this method in a short series of 40 cases. A review of our experience does not leave anything to regret.

Our 38 cases constitute the following operations :

Total Hysterectomy	1
Appendectomy	4
Laparotomy	6
Cong. Ing. Hernia child group	4
Inguinal Hernia adults and aged inclusive	25

Constant impact of knowledge through literature roused our enthusiasm on this subject. We incorporated this method of care in 1945 in our post operative treatment of cases of hernia to start with. We never had any occasion to compel our patients flatly to get up. A laborious counsel to the patients on the simplicity of the procedure and its advantages induced a confidence among them though they were hesitant and apprehensive of things rupturing inside. Some times we had occasion to make new comers see the already operated patients moving about. This enormously improved the morale of the prospective patient.

We had to do a lot of talking in a leisurely and laborious method before we could get most of the patients even to turn to the side. Some would tell us that they may be allowed to get up on the 2nd or 3rd day.

We were so painstaking that we could convince every one of them, even an aged woman of 60 from the village, about the efficiency of this, that, we had no unsurmountable difficulty of rousing them to ambulatory activity, according to programme. A young man from Simla wrote to us in so much praise of our method that we felt very elated. The Simla man had a previous hernia operated elsewhere in bed-rest for 3 weeks and hence he could assess the value of his previous and recent experience of hernia surgery.

Our hernia cases had a pre-operative look up of motions, urine and blood counts though we were ambitious to estimate their blood proteins as well. The latter could not be done for want of facilities. In our series we would make our laparotomy cases "Good Risk" ones, but the gastric perforations were emergencies.

I am only anxious to review our hernia cases in this paper.

We make a 4" to 5" transverse crease incision with the lateral 2" somewhat curved upward and outwards. We invariably employ spinal. In our series of 25 adult hernioplasty 20 had spinal and 5 had chloroform ether mixture. Children had pure ether. We use 60 cotton for ligature of blood layers. Thin silk is used for darning. We of Willy's Andrew's technique and leave intradermal cotton. Sulphanilamide powder is insufflated in the various anatomical planes.

The closed wound is covered with spirit-soaked gauze and strapped by adhesive plaster tightly. We don't use any bandage.

For ambulation we follow Lithauser's Technique in spirit though not to the very letter. It is done thus.

On the night of operation, the resident compounder helps the patient to sit if the patient so desires, to pass urine. Otherwise they are left alone. In our series, 15 could pass urine in recumbancy 2 required catheterisation and 8 were helped either to sit or turn to comfort. 2 had post-spinal headache requiring pethidine and I. V.

glucose. Post-operative discomfort is a personal factor. The villager required no sedative but the highly-strung patients required bromide. The next morning at about 10 A.M. i.e., after about 20 to 24 hours, we start the routine getting up.

The patient is asked to turn to the side of the incision and flex his knees and hip and raise himself by exercising of the normal flank muscles. He puts the feet on bedside stool and stands. As he stands, he is asked to take a few deep breaths, and cough voluntarily. While standing many shake on their limbs due to fear apprehension and pain which they do have to some extent. Very occasionally the spinal patients cough up some mucus. The general anaesthetised always expectorate some sticky fluid; some of them an amazing quantity. In a few moments the patient feels more comfortable and bold. He sits and lies down himself with some assistance and coaxing. After the initial getting up he feels pain less and less.

After another 4 hours, he gets up as described above and walks a few steps to a chair beside and sits there for a few minutes and goes back to bed. This he repeats in the evening and night.

Next day, i.e., 3rd post-operative day, he walks a distance that he feels confident of, as many times as possible. Majority of them seldom have the initiative to do the walking a number of times themselves. On the 4th day they report at the dressing room usually about 60 to 80 feet from their bed. Dressing trolley rarely goes to the bed for supervision and dressing of wound on the 4th post operative day. In our series, 3rd day dressing had to be done in bed in 5 of the patients who could not be persuaded to walk to the dressing room. For suture removal the patient again reports at the dressing room on the 9th post-operative day. By the 9th day the patient had been on so much of ambulation that he seldom shows any out-of-the routine feeling. He is used to walking and he does it. 90% of them required no enema and none of them had nausea, vomiting or

distention except 3 of the 5 anaesthetised, who had some nausea and a feeling which they explained as "liverish". All of them were allowed any food, of non-residue variety, if they had passed motion and flatus previously. Our single resident compounder and duty ward-boy had very little to do for these cases by way of nursing care. Our 4 appendicectomy patients had uneventful ambulation. All of them were educated and could follow our instructions without grave apprehension. They remarked that the ambulation was wonderful for body and mind. We were so proud to see our appendix cases walk to dressing room on the 4th day for scrutiny of wound. The patient-surgeon feeling was very cordial since the surgeon could see his patient moving about with an all pleasing attitude.

The children were allowed to be carried on shoulder of parents, all over the place and this saved the child so much of crying and the parents so much of a temper. The children were left to activity and parents were never bothered to put them to bed since we believed that the wound certainly would exercise a reflex inhibition of dangerously brisk activity.

In our series none of them had any episode of wound disruption or infection. 4 had tiny stitch abscesses with some suture material projecting into the wound. We pulled out the suture as far as it would come and cut the deep portion and allowed it to retract after a dab of mercurochrome. This usually was sufficient to cure the stitch sinus.

A 50 year old man who reported to us 2 months after discharge with a stitch abscess presented silk in the wound. We could pull out the whole length of silk that we had used for darning to our great annoyance. After a year he reported to us last month with a recurrent direct hernia.

We had no patient, developing pulmonary vascular or gastro Intestinal complications.

In our laparatomies we did the routine vertical incision much against our will

inspite of the fact that transverse incisions are better. The gastric perforation cases were not fit for ambulation since they had peritonitis and was controlled by penicillin, exercises as soon as they were fit to. They the legs and were instructed to be sitting than lying.

### SUMMARY

Early ambulation is advocated as sound post operative care in point of view of physiology, psychology and economy to patient and hospital. Hospital accommodation is conserved and patients return to work early with very pleasant memories of their surgery. The nursing staff have very little responsibility of any nursing that would otherwise have been necessary in bed-resting patients. Hazards of major surgery like atelectasis, hypostatic pneumonia, phlebothrombosis embolism, asthenia, ileus and other gastro-intestinal complications are seldom seen. Post-operative complications do depend on age, type of operation, and nature of disease. Ambulation alone, does not answer all points.

The patient's morale is fine throughout, with no anaesthesia or decubitus. Catheterisation, enemata and sedatives are seldom necessary.

With present day advances in technique and availability of fine ancillaries like penicillin and sulphadruugs in control of wound infection, early ambulation should be established rather than challenged.

Indications are "Good Risk" patients as understood by a modern surgeon.

Contra-indications are cases of peritonitis, haemorrhage, shock, etc.

Transverse incision and non-absorbable sutures are recommended.

Morale and economy considerations are good in patients' point of view.

This regimen is not to be understood as one of a forcible flat compulsion of the patient to get up and walk.

Encouraging and reassuring patient-contact are essential in achieving success in getting patients out of bed.

### CONCLUSION

An attempt has been made to define the technique of early ambulation.

The advantages, the indications and contra-indications are brought out.

Experience in a small series of cases is the basis of our enthusiasm in presenting this paper.

These patients look after themselves, and demand very little nursing.

Surgery is not viewed with horror by these patients.

With this programme in full swing, the task of the surgical unit is very simple in the post-operative period.

### POST SCRIPT

Since reading this paper we have come across J. B. Blodgett & E. J. Beatties' article on "The effect of early post-operative rising on the recurrence rate of hernia." Their review comprising an analysis of 180 cases of inguinal hernia treated by post-operative bed rest gives a recurrence of 6.1%, whereas the recurrence rate in 150 early bed risers was 6%. They conclude that early rising does not significantly affect the recurrence rate of Hernia.

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## BONE GRAFTS

by MAJOR H. R. PASRICHA IMS/IAMC.

Nearly 88 years ago, in 1859, Ollier first published his results after performing a systematic examination of bone grafts. He believed that an autogenous graft was kept alive by its own periosteum until it became revascularised. In 1893, Barth came to exactly opposite conclusions. He reported that any graft, whether covered with periosteum or not, always became necrotic in all its parts together with its periosteum and endosteum and that the necrotic bone was regenerated by osteoblasts derived from the neighbouring sound bone of the host. These observations were refuted by Axhausen after the performance of several well controlled experiments and supported by the clinical experience of Lexer. According to them though transplanted bone necroses periosteum and endosteum do not necrose and they are responsible for regeneration of bone after they have become revascularised. Albee thought the fate of a graft depended upon its exact environment and that the chances of survival are increased by exact approximation of the graft with the host bone. He adds that periosteum and endosteum play an important role in establishing early and abundant blood supply. Murphy, however, believed that the graft is, per se, not osteogenic but osteo-conductive and regeneration cells are supplied from the osteogenic cells of the capillaries growing from the living bone of the host.

MacEwan also denies any osteogenic power in the periosteum. Leriche and Policard explain the regeneration of bone according to their theory of metaplastic processes. Regeneration is carried out by fibrous tissue cells which penetrate into the graft and are converted into osteogenic cells through metaplasia. Matti found that spongiosa bone shaved into small pieces and transplanted survives in all its parts. Its loose structure helps in quick establishment of circulation. He concludes that the transplantation of

spongy bone can be carried out successfully in non union.

During this war a large number of bone graft operations were necessitated by war injuries and performed by me at 7 I.B.G.H., Poona. Experience gained as a result has helped to convince me that the classical technique of bone graft as taught in books will have to be altered considerably if better results are to be obtained.

All the cases were compound fractures resulting from war injuries in the field. All of them had had benefit of efficient forward surgery,—penicillin and efficient splintage. The resulting non-union was invariably due to excessive loss of bone substance either initially or later on due to infection.

In the beginning all cases were grafted according to the classical technique advocated in most orthopaedic books. They were all tibial grafts removed with the help of an Albee's saw and fixed with the help of stainless steel screws. All cases were done under Penicillin umbrella and no cases developed any kind of sepsis; all healing was by first intention. It was felt, however, that bone grafts took a very long time to unite securely although the parent bones were small long bones, like the Radius, in most cases. Also, even when the graft united, which it did in all cases, there was not much evidence of new bone formation around it for months. This left the bone weak and liable to easy refracture.

The following representative cases in this series will illustrate the point. In some of these cases the grafts were fixed with steel wire. Although it does not seem to have made much difference in union, this method of fixation is not advocated. It had to be adopted on account of war scarcity of medical appliances which became unavoidable at certain periods.

## Case 1. (Fig. 1.)

R/M L.S. 1/10 G. Rifles—sustained G.S.W. left forearm on 11-5-'44 Comp. Fracture both Radius and Ulna. Extensive lacerated wound dorsum of Lt. Radial and Median nerve lesions also. Admitted Lt. forearm with considerable laceration of muscles. 7 I.B.G.H. on 8-9-'44; un-united fracture Radius—Ulna united. Wrist drop and signs of median lesion present. Wound still discharging. Sinus healed on 10-1-45. Tibial bone graft inserted between freshened bone ends on 12-9-45. Cortical inlay fixed with wire. Graft united on 11-9-46.

tween fragments of Radius. Wound healed. Median nerve lesion. By 24-4-46 Median nerve had recovered considerably. Operated on 29-4-46. Gap 10½" Tibial graft inserted and fixed with screws. Cortical inlay. Graft fully united on 8-10-46.

## Case 4. (Fig. 4.)

R/M N.L. 2/8 Gurkha Rifles Wounded on 17-12-44. G.S.W. left arm: compound fracture shaft Humerus lower third. Wound excised. Secondary suture with Penicillin.

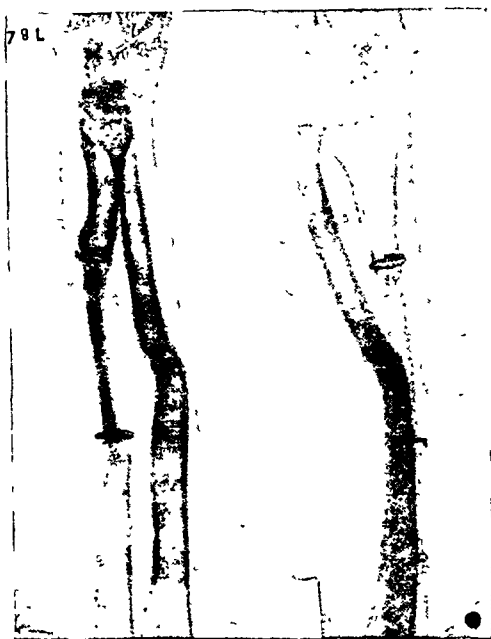


Fig. 1.

## Case 2. (Fig. 2.)

L/Nk B.R. 6/7 Rajput regt. sustained G.S.W. of left forearm and comp. fracture of Radius (2-3-45) admitted to 7 I.B.G.H., on 22-6-45. No union of Radius. Arm still in P.O.P. Signs of recovering lesion of Median nerve. Thenar muscles still wasted and not functioning—Time was given for the nerve recovery to take place. Bone graft on 25-1-46. Tibial graft inserted between freshened bone ends. Fixed with screws. Cortical inlay. Graft fully united on 6-9-46.

## Case 3. (Fig. 3.)

Jem. H.R. 2/10 G.Rifles G.S.W. wounded in C.M.F. on 19-4-45 Compound comminuted fracture lower third Radius. Wound excised. Delayed primary suture with Penicillin. Admitted to 7 I.B.G.H., on 1-10-45. X-Ray showed a gap be-

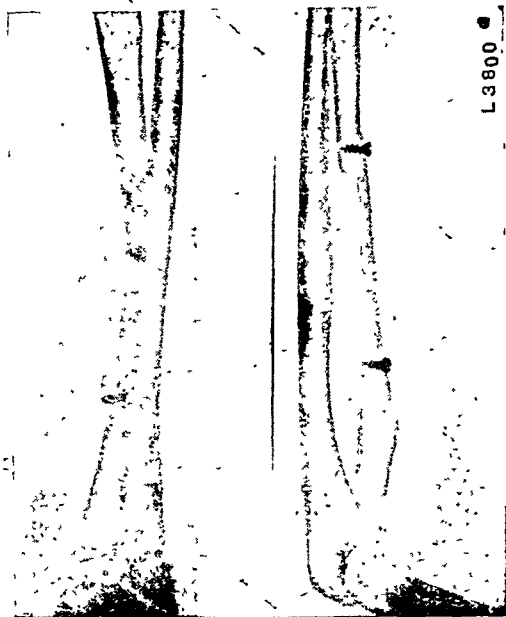


Fig. 2.

Admitted 7 I.B.G.H., on 23-4-45. On removal of P.O.P. X-Ray showed un-united fracture Humerus and Sclerosis of bone ends. Operated on 18-6-45. Gap 10 cms. Bone ends cleared. Two Tibial grafts inserted and fixed with steel wire. Graft united on 26-4-46.

The results of these cases were obviously disappointing. The grafts took 12, 8, 6, and 10 months to consolidate and even then there was not enough new bone formation around the grafts to entitle them to be considered secure. It was clear, on a review of the results of this series, that cortical graft, per se, did not possess sufficient osteogenic power and had to be re-inforced by tissue which would stimulate more bone formation. The answer was spongy bone. In the next series, therefore, all cortical grafts were re-inforced by spongy bone. The results were encouraging, only two cases of this series are quoted here.

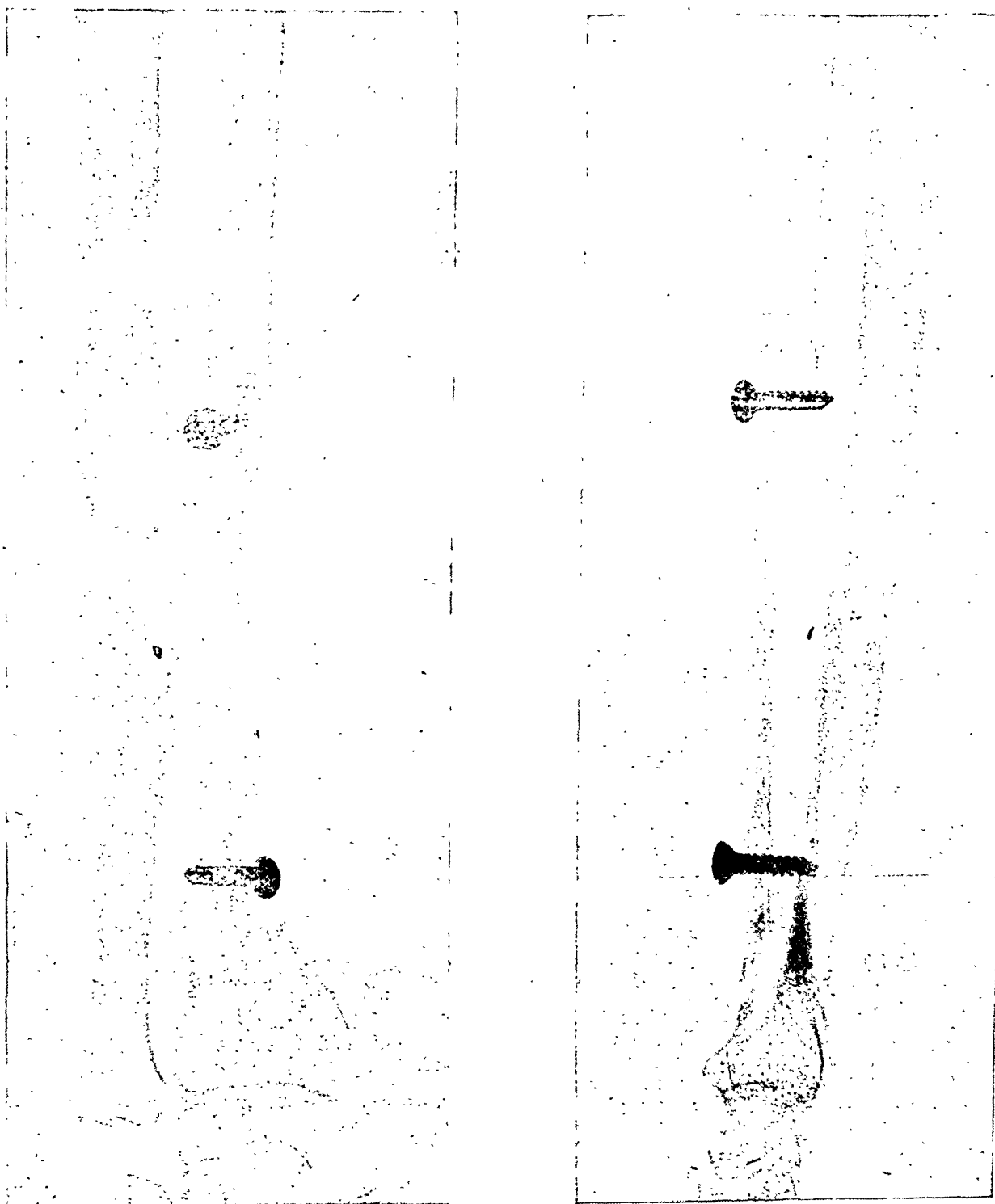


Fig. 3.

## Case 5. (Fig. 5.)

Hav. R.C.C. 1/5 M.L.I. wounded on 19-10-44 shell wound. Large wound back of Lt. Arm with compound fracture left Humerus, lower third. Wound explored and cleaned on 20-10-44 at 8 C.C.S. Fracture Humerus and Radial nerve completely torn. Thoraco-brachial P.O.P. Transfer received in 7 I.B.G.H., on 23-4-45. Still in P.O.P. Radial palsy present. X-Ray shows no union of bone at all. WR & Kahn negative. Operated on 29-5-45. Bone ends exposed and freshened. Very small lower fragment. Tibial cortical graft inserted and fixed with screws. By 16-4-46 it was apparent that though graft had taken firmly at the upper end, it failed at the lower end.

2nd operation on 5-8-46. Bone ends exposed and excised. Large tibial graft fixed with the help of stainless steel screws. Gap filled in with cancellous tissue. On 21-4-46 the graft was already showing signs of union and new bone formation.

## Case 6. (Fig. 6.)

R/M B.B. 3/1 G.R. Wounded in Burma on 5-2-45 G.S.W. Supra-Condylar fracture of Hume-

terior displacement of lower fragment 30-5-45. No union at all. Transferred to I.B.G.H. on 19-6-45. Un-united fracture Humerus. X-Ray shows a big gap. No likelihood of union. Elbow ankylosed. A big scar on the anterior aspect of elbow and lower part of arm. Scar excised and a pedicle graft of skin transferred to the arm. By 6-5-46, the skin graft had taken well. WR. and Kahn negative.

Operation on 31-7-46. Bone ends exposed. Lower fragment very small. One Tibial Cortical graft fixed with screws. Intervening gap filled in with cancellous tissue removed from the Ilium. By 30-11-46 graft was showing good union.

## DISCUSSION

The first case is interesting because it had both varieties of grafting operations performed. A cortical tibial graft in the first instance failed to unite at the lower end. When combined cortical and cancellous grafts were used good bone formation resulted in 3 months. Similarly in the



Fig. 4.

rus and Radial nerve palsy. Operated on 21-3-45 at 130 I.B.G.H. at Lucknow. Lower end of Humerus found projecting through the wound. Necrosed. Vaseline gauge dressing. Operated on again on 12-3-45 at the same hospital. Projecting lower end of Humerus was excised and arm put up in P.O.P. X-Ray after operation showed pos-

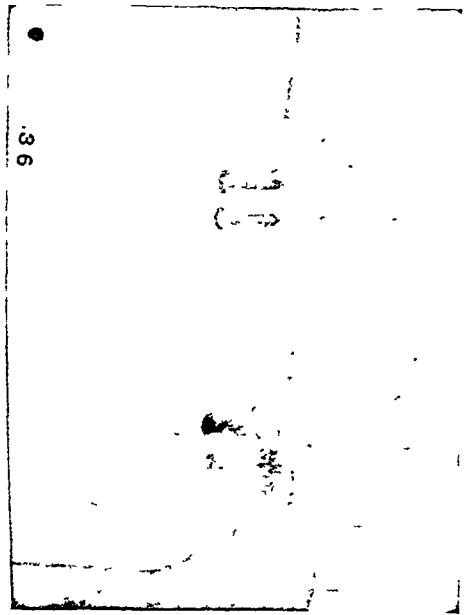


Fig. 5.

second case enough bone formation was in evidence in 4 months to pronounce the graft a success. After this another change in the technique was introduced. It was certain by now that the cortical graft, per se, possessed little osteogenic power and, probably,

served no other purpose than that of general support and holding the fragments together. It was considered likely that a metal plate could perform both these functions more efficiently. This would incidentally, simplify the technique by omitting the removal of a graft from tibia. In the next series, therefore, the freshened bone ends were held together by a plate and screws and the intervening gap between the ends filled with cancellous tissue removed from the Ilium. Three cases of this series are included.



Fig. 6.

#### Case 7. (Fig. 7.)

Sep. S.S. 7/8 P.R. wounded in Malaya on 11-2-42. G.S.W. left arm. Fracture Humerus. Became a prisoner of War. Released in 1944. On 10-5-44 fracture still un-united. Has had Beri-Beri. Still has a discharging sinus in the middle of arm inspite of having had an operation of sequestrotomy during captivity. Transferred to 7 I.B.G.H. on 25-10-45. X-Ray shows non union. Discharging sinus present. Sequestrotomy on 1-3-46. Sinus

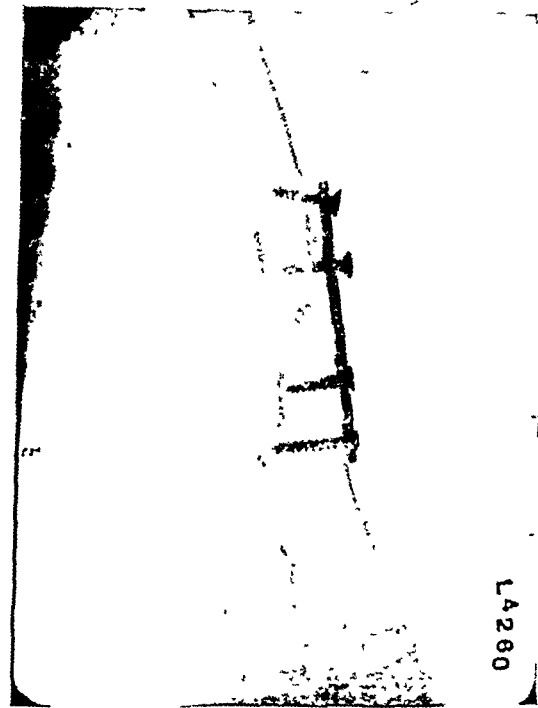


Fig. 7

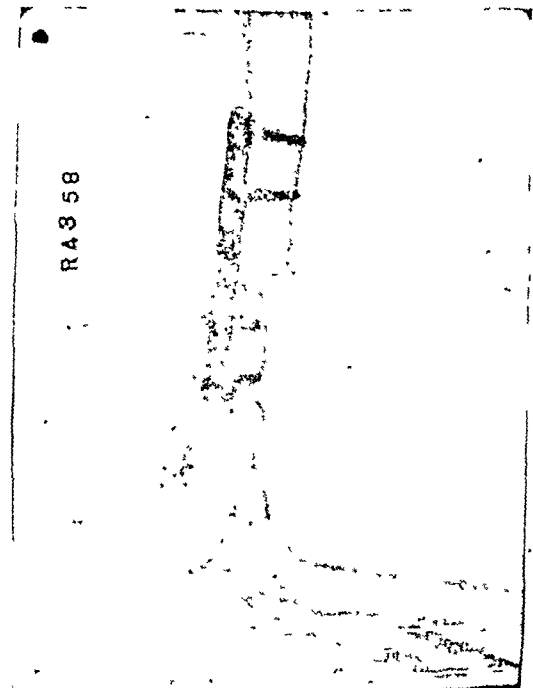


Fig. 8.



closed subsequently. On 16-4-46, operated on again. Bone end exposed and freshened. Bone ends held with the help of a plate and screws and the gap filled in with spongy bone from the Ilium. By 26-11-46 graft had united well and there was plenty of new bone formation.

#### Case 8. (Fig 8)

L/Nk T.B. 1/4 G.R. wounded in Burma on 25-11-43 Grenade wound Rt. Arm with compound fracture Rt. Humerus, penetrating elbow. Grossly



Fig. 8.

lacerated wound. Disorganisation of elbow joint comminution of upper ends of Radius & Ulna. After having been treated in various hospitals, he was finally transferred to 7 I.B.G.H. on 2-5-45. No union at all, big gap between bone ends. Multiple sequestra. Sinuses discharging. Two operations of sequestrotomy cleaned up sepsis and sinuses closed. By now elbow completely ankylosed. Operated on 9-4-46. Bone ends exposed, freshened and held together with plate and screws. Gap filled with

cancellous bone from Ilium. By 12-10-46, union was complete.

#### Case 9. (Fig. 9.)

L/Nk MS 4/7 R.R. wounded 9-4-45 G.S.W. left thigh and Rt. heel. Fracture lower 3rd left femur and os calcis (Rt) Wound cleaned and explored the same day at 19 C.C.S. Excision, loose pieces of bone removed. Put up in Tobruk P.O.P. Transferred to 77 I.G.H. on 14-4-45. Skeletal traction

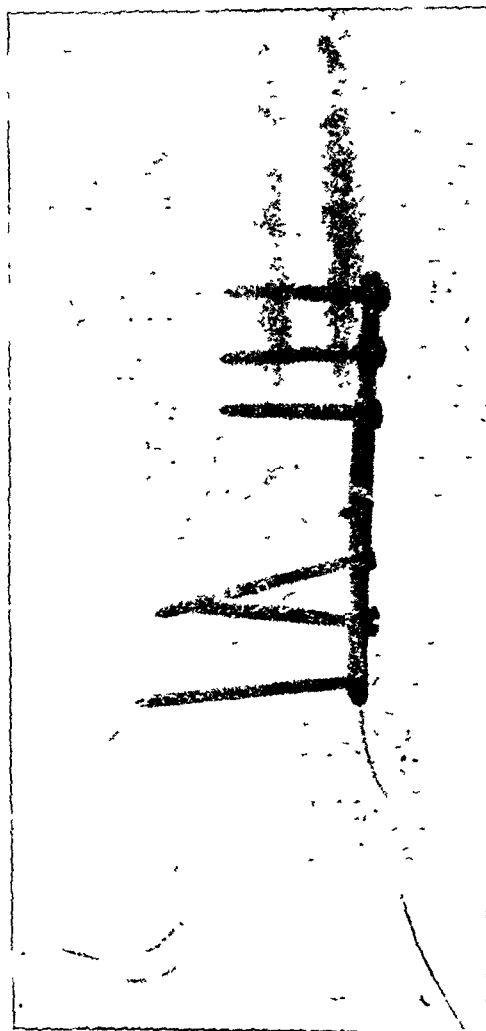


Fig 10

through Tibial tuberosity applied. Secondary sutures to wound on medial side with penicillin. Lateral wound cleaned, two pieces of dead bone removed. Sutured with drainage. Traction 15 Lbs. in a Braun's splint.

19-5-45 wounds healed. X-Ray shows postero-displacement of lower fragment. Attempts made to correct displacement with the help of pads proved of no avail.

Transferred to 62 I.G.H. on 17-8-45. Patient now showed signs of peroneal nerve palsy probably due to the pin.

Transferred to 7 I.B.G.H. on 8-12-45 X-Ray shows a big gap between fragments with only a narrow ledge of sclerosed bone. (Fig. 9.)

On 13-8-46 patient slipped and broke the femur. Operated on 16-8-46. Bone ends exposed and freshened. Gap at least 2" approximated as far as possible and held together with a vitallium plate and screws. Intervening gap filled with cancellous graft P.O.P. hip spica.

By 6-11-46 although union was not complete enough bone formation had occurred to call the graft a success. (Fig. 10.)

## DISCUSSION

These cases show that though the Tibial graft was omitted and replaced by a plate, the results continued to be eminently satisfactory and the period required for new bone formation and consolidation was considerably reduced. Obviously the next step was to try and see if the internal fixation could be dispensed with altogether. It was realised that doing away with internal fixation altogether in case of certain bones would not be devoid of risk, e.g. Femur and Humerus for the simple reason that our methods of external fixation in these two bones are not satisfactory. Hip and thoraco-brachial spicas do not secure complete immobilisation of these bones. Forearm and leg bones can be effectively immobilised by external methods. It was, therefore, decided to employ this technique in the latter bones only. This technique was used concurrently with the other series. Only one case is described in detail here.

### Case 10.

Rect. R.S. 2 M.T.T.C. Involved in a lorry accident on 25-7-42. Compound fracture Tibia and Fibula (Rt.). Admitted to 8 I.B.G.H. on the same day. Deep wound (12" x 6") Rt. Leg with gross damage to muscles. Bone ends of Tibia exposed. Gap at least 2". Excision Vaseline gauze dressing P.O.P. A.T.S. given. X-Ray showed comminuted fracture of middle of shaft of Tibia- & Fibula. Fragments wide apart indicating loss of bone. 15-2-43

operated on. A cortical bone graft was taken from left Tibia and inserted into Rt. Tibia.

29-9-43 X-ray showed separation of fragments with the graft showing in between.

25-2-44. There is obvious absorption of graft. No sign of new bone formation. No union.

12-10-44. Admitted to 7 I.B.G.H. Discharging sinus present although the notes do not say so. The bone graft has almost completely disappeared. (Fig. 11.)

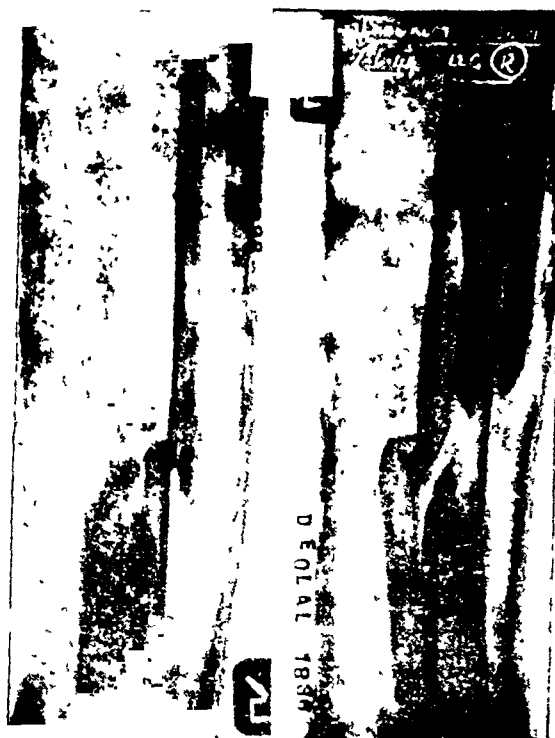


Fig. 11.

9-3-45. Has formed an abscess locally. Opened up. A few days later the graft was extruded.

26-9-45. Wound finally healed up.

5-2-46. Operation. Bone ends exposed and freshened. Gap 3". Gap filled in with cancellous bone from both ilia. Soft tissue sutured over. P.O.P.

26-9-46. Tibia has united firmly, but Fibula remains un-united. (Fig. 12)

## DISCUSSION

This case shows that firm fixation is necessary in cases of cortical grafts. The first graft in this case had no chance of taking because apparently no method of firm fixation was used. Obviously, close approximation without firm approximation is not



Fig. 12.

enough. The same, however, does not seem to be true in case of cancellous graft. On account of its superior osteogenic power it can unite even though no form of internal fixation either of the ends of the host bone or of the host bone and graft is employed.

### CONCLUSIONS

1. From these results it is obvious that cortical grafts by themselves have very poor osteogenic power and, in main, they serve no other purposes than of holding the fragments together till osteoblasts from the ends of the host bone and cancellous tissue taken into the graft accidentally during removal can regenerate bone. Very likely, good results reported with cortical grafts in the past were due to a certain amount of cancellous tissue removed along with the graft. Cortical grafts take a long time to consolidate and longer still for enough new bone to be formed to reconstitute the girth of the bone. In bigger bones this is a matter of a year atleast.

2. This prolonged period of immobilisation adds another problem to that of reconstitution of bone; the problem of restricted movements in the immobilised joints. It has been our experience that it takes several months for the joints to recover enough movement to restore the function of the limb to a reasonable degree.

3. Cancellous bone is far superior to cortical bone as a graft. It has much greater osteogenic power. The graft takes easily and the host bone is reconstituted much earlier, thus reducing the period of immobilisation of joints. The function of the limb is restored much earlier.

4. In bigger bones, e.g., Humerus and Femur the ideal method would be to use a plate and screws to hold the bone ends together and fill the gap with cancellous bone which is easily removed from the Ilium. In other bones like Tibia and Radius cancellous tissue alone would seem to be quite sufficient for reconstitution of bone.

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## CASES & COMMENTS

### A CASE OF TOTAL PNEUMONECTOMY\*

by J. A. DHACKA

Removal of the lung has been an established procedure since the days of McEwan, and studies by Kayne, O'Shaugnessy, Tudor Edwards, Reinhoff and many others have put the operation of Total Pneumonectomy on a more scientific and studied technical basis.

As a well planned operative procedure, total Pneumonectomy has been advocated and successfully performed for :

1. Suppurative diseases of the lung.
2. Bronchogenic Carcinoma.
3. Tuberculosis of certain types.
4. Extensive laceration of the lungs and uncontrollable bleeding including the hilar tear.

Cases of the last group are few in proportion to the published series in the first three groups, because traumatic cases may not have presented themselves in time for a successful operation. Further, the clinical picture presented by these traumatic cases might have exhibited complex syndromes due to concomitant injuries to the vital adjacent mediastinal viscera so that quite many of such cases may not have come to the operation table having died during the observation and resuscitation stages ; the modern teaching and practice of ultra conservatism in the treatment of Thoracic injuries may also have partly contributed to the paucity of the last named group in the published cases.

The case reported herein is meant to illustrate the difficulties that a surgeon may come across in the emergency treatment of intra thoracic bleeding of unknown origin ; planning of the operation is out of the question, attendant facilities such as modern methods of anaesthesia are not available, expert assistance during the course of operation is rare, and methods of resuscitation

of cases, pre operative and post operative, are not always ideal or administered in time.

#### CASE REPORT

EPR No. 17002 — 8416. Name : Shankar Ramachandra, Hindu, Male, Age 25. Was brought to the Blood Bank of the J. J. Hospital at 3-30 p.m. on 23-12-46 from the casualty department (where he was admitted at 3-20 p.m.) with the following notes :

"Assaulted with knife, incised wound  $1\frac{1}{2}$ " x 1" x ?" on the left side of the chest 2" below the clavicle. Patient under severe shock. General condition bad. A.T.S. morphia given."

On examination he was in an extreme degree of shock. Skin was cold and clammy, perspiring all over. Tongue, nails and conjunctiva were pale, the pulse was feeble, thready and of low tension, the rate was more than 150, respirations were 38 to 34 per minute and there was marked air hunger.

Local examination revealed a stab wound  $1\frac{1}{2}$ " x 1" x ?" in the left second intercostal space medial to the left mid clavicular line. There was



Fig. 1.

\*From the surgical wards of the Sri J. J. Hospital, Bombay. The author acknowledges with gratitude the valuable help rendered by the Staff of the hospital.

profuse bleeding from the wound over which a sterile pack of dressing had been applied. There was no surgical emphysema, the respiratory excursions of the chest were limited, the percussion note



wound, 2" in length, and admitting the index finger, was noted extending from the anterior surface of the left lung to the mediastinal surface in front of the upper border of the hilum. On mopping further, a fresh gush of blood from the mediastinum was provoked and instinctively the left hand was passed keeping the dorsal surface of the hand against the mediastinum and feeling the pulsating heart on the dorsum of left hand from underneath the left pulmonary ligament thus engaging the structures of the hilum between the index and middle finger and controlling the bleeding from the hilum by adductor grip of the first two fingers. Slackening the grip of the two fingers revealed fresh bleeding from the upper pulmonary vein which lies in front of the bifurcated main

bronchus and from a tear in the left pulmonary artery. A large, curved pedicle clamp was applied from above downwards medial to the "Finger Haemostat"; the thoracic cavity was mopped dry and remained dry. A large curved blunt pointed aneurysm needle was threaded with long No. 4 silk and a transfixation suture was placed medial to the clamp, the pulmonary artery, upper bronchus and upper branch of the pulmonary vein occupying the upper circle and the lower bronchus and pulmonary vein occupying the lower circle of the suture, and a surgeon's knot was tied home relaxing the clamp during the process of tying. The ligature was left long for a time and the collapsed lung was excised by cutting with Mayo's scissors from above downwards lateral to the curved blades of the



Fig. 3.





5. One pint plasma.
6. Morphia 1/6 gr. with Atropin 1/150, 6 hourly, 3 times.
7. Intra-venous glucose 50 c.c. 25% with Vitamin C daily.
8. Nursed on back in semi-reclining position.

#### 2nd week :

1. Samé medication continued.
2. Patient developed symptoms of Nephritis which was symptomatically treated.

#### 3rd week :

1. Oedema disappeared.
2. Urine normal, blood pressure 105/80.

Temperature touched normal for the first time on the sixth post operative day. (Vide: Temperature Chart Fig. 2.) Pulse rate came down to 100 on the sixth post-operative day and the respirations to 26. Amount of urine ranged about 32 oz. for 24 hours. Alternate stitches removed on the 12th post operative day; all stitches removed on the 16th day. On the 17th day, the patient tried to sit up on the bed and this caused partial dehiscence of the wound which was strapped by Elastoplast.

#### 4th week :

Most of the medications stopped.

Skiagram of the chest taken 49 days after operation is shown in Fig. 3.

#### Cardio-Respiratory Studies

1. Electro Cardiograph report:—  
Vide Chart. Fig. 4.
2. (a) Vital capacity 1700 c.c.  
(b) Respiratory rate 23 per minute.  
(c) Supplemental air 900 cc.  
(d) Complemental air 800 cc.

#### 5th week :

Patient developed slight jaundice with the following findings and was treated in the usual way:—

- (a) Serum Bilirubin 8 mg.
- (b) Icteric index 40 units.
- (c) Vandenberg reaction direct positive.
- (d) Bile pigments present in urine.
- (e) Bile salts absent in urine.

#### 6th week :

1. Jaundice disappeared.
2. Most of the medication discontinued.
3. Plasma proteins total 6.10, Albumin 3.10, Globulin 3.00.

### SUMMARY

1. A case of Left Total Pneumonectomy is reported.

2. The rarity of cases of total pneumonectomy for injury is possibly due to the cases arriving too late for successful surgical aid and to the attendant injury to mediastinal structures.

3. Mass ligation of the hilum was done in this case without the usually dreaded complications.

4. Pleuralisation was not done.

5. Drainage dispensed with for the following reasons:—

- (a) Fear of total pneumothorax during post-operative period and bad management of the drainage tube.
- (b) Limited utility of any drainage due to blocking after 24 hours.
- (c) Leaving the tube for a few days leaves the stab hole as a button-hole with the attendant dangers.
- (d) If exudate forms, then it can always be aspirated.

6. With firm closure of the bronchus, the possibility of tension pneumothorax was but little, but in view of the above the risk was taken.

7. Massive use of penicillin contributed considerably to the successful recovery of the case.

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### Proceedings of the IX Annual Conference of the Association of Surgeons of India

The IX Annual Conference of the Association of Surgeons of India, was held on the 26th, 27th, 28th and 29th December 1947 at the J. J. Hospital, Bombay. During the same week, various Medical Organisations also met at Bombay in the same compound.

More than one thousand five hundred doctors who represented the various Associations had a happy and profitable time.

Our Conference, which was very well attended was, as usual, a grand success.

Rao Bahadur Dr. M. G. Kini of Madras presided and Drs. Arthur DeSa' and V. P. Mehta were the Local Secretaries. They were helped by a group of Student Volunteers from the Medical Colleges

at Bombay, and the arrangements made for the accommodation and transport of the visiting members were excellent.

The formal inauguration of the Conference took place on the 26th December at 9 A.M. in the Conference Pandal. The Hon'ble Dr. M. D. D. Gilder, M.D., F.R.C.S., etc., Minister of Health and Public Works, Govt. of Bombay, declared the Conference open.

In his inaugural address, he appealed to doctors to remember and stand by the "humble" ideals of the Medical Profession. Dr. Gilder said, Conferences of that kind not only helped members to listen to Scientific papers read by eminent Doctors, but also, what was more important, enabled them to establish contact with doctors from all over the country.

Referring to the paucity of Surgeons in India, Dr. Gilder said, there was difficulty whenever an important post of a Surgeon had to be filled in. It was his constant "headache" to create Surgeons to train them up and to keep them "up to date". There were hardly any facilities for adequate training in the country.

The primary function of a University, as far as Medical Education was concerned, Dr. Gilder declared was to produce a large number of "good Medical Practitioners", who would tackle common emergencies and ordinary illnesses. He could not understand why there was such a very large number of failures in the Medical Examinations of the Bombay University. He asked "is it because of poor teaching, or of the high standard of the tests or of bad material?"

Dr. Gilder welcomed the suggestion made by the Hon'ble Mr. M. C. Chagla, Chief Justice, that Examiners should be appointed by a Public Service Commission.

Then, Rao Bahadur Dr. M. G. Kini, in his Presidential Address said:—

### PRESIDENTIAL ADDRESS

by M. G. KINI

It is indeed a rare honour and privilege that has fallen to my lot that the Association of Surgeons of India should have elected me as their President for this year. This is a momentous and epoch making year on account of the fact that we as a nation have undergone a transition in our phase of life from dependence to independence and it is my hope that the Association of Surgeons which was started nine years ago for the furtherance of independence in thought and deed about the art and science of surgery in our country will get an added stimulus to raise the standard of surgery in

India to the level obtaining in other parts of the world and will find an honourable place in the surgical map of the world.

Another notable feature of this year is a gathering of all medical men in India in a medical-conference and festival for the first time. With the experienced gained, it should be possible to devise plans for such common meetings at least every 5 years. It is, however, my opinion that specialist conferences must not lose their identity and must carry on their specialist good work to raise the standards of medical relief on a competitive basis, and also be of use to the general practitioner. Once in 5 years all the specialist conferences must pool their resources for mutual advantage and at the same time be of use to the general practitioners in enlightening them on the advances made.

I may be forgiven, if I strike a personal note. I feel proud that Bombay which gave birth to this Association of Surgeons of India has given me the rare honour to preside over this function in Bombay, where it is meeting for the second time. It is here that I read my first paper on the work I had begun to do. Bombay, a cosmopolitan city, always welcomes and attracts people of all presidencies and businesslike in its methods, evaluates the merits and demerits and is generous to a fault without any sense of parochialism. I do not know whether I will come up to the standards which have been laid by my predecessors in this chair. With your help and co-operation I will try to discharge my duties to the best of my ability.

My predecessor has gone through the history of surgery including evaluation of the present standards. I wish to speak on some of the fundamental aspects of medicine in general and surgery in particular as it affects the profession due to altered circumstances in our country to-day.

### Problem of Indigenous Medicine

Evolution of medicine from its crude conception to the modern attainments deserves a retrospect to understand perfectly its scope and usefulness in the solution of the problem of human ills. Time was when human beings in their desire to save life from acute infections and diseases invoked spirits, practised incantations and sacrifices with the object of appeasing the spirits. Later, when human intelligence improved and division of labour occurred in the community, a medicine man appeared on the scene who in addition to invoking the spirits, tried plasters, used infusions, decoctions and various vegetable and mineral drugs.

Thus, the medicine man was the first phase in the evolution of medical relief. Later, it led to the development of a medical profession. There were certain landmarks during the progressive evolu-

tion, when great men of thought in medicine, by their attainments and clear thinking, developed centres of learning, and tried to pull out medicine from the quagmire of superstition, empiricism and sophistry. From time immemorial, the medical profession has exercised its beneficent sway for the relief of the diseases without distinction of caste, creed or race. Whenever any progress has been made in any sphere of its activities, it always tried to disseminate knowledge for the cure of diseases about which ignorance prevailed. When medical men became secretive, and commercialised their knowledge, medicine became degenerate, and unauthorised people began to practise magic cures by free advertisement. Thus, the science and art of medicine was pulled down from its high pedestal, retaining only the fictitious halo of glory of its usefulness. These are the reasons which led to the decadence of ancient medicine including our indigenous medicine. The progress of the modern phase synchronised with the renaissance of all basic sciences when it began to investigate into the mysteries of nature, revealed by experimental investigations and clear observations and by a study of the whys and wherefores of things observed. Astronomy, Physics, Chemistry, Biology, in their awakenings had rude shocks and vicissitudes through which they had to pass due to religious barriers and conservatism which were predominantly prevalent at the time. But science could not be trampled upon and it ultimately triumphed due to the strenuous efforts of savants who sacrificed their lives and their all in the cause of this noble objective.

Medicine from its empiricism of the use of mere plasters decoctions, drugs and various methods of treatment, flowered into a science when it began to accept scientific concepts of physics, chemistry and biology. Knowledge of chemicals led to their scientific application in the prevention and cure of disease. Medicine in its evolution had stages of progression and retrogression corresponding to political upheavals, invasions and natural causes due to inherent defects. A clear and better understanding of the structure and function of the body and its relation to heredity and environment has evolved a better scheme of natural health. A knowledge of the living organisms both beneficent and malevolent to human beings has helped both in the curative and preventive aspect of disease.

Split minds in medicine exaggerating the usefulness of things of the past by comparing with the conditions obtaining at each period, must have existed and are still existing. The Indian Nation which is passing through a renaissance period of nationalism has also got its split mind in evaluating the methods of medicine. Everywhere there is a keen desire to progress in scientific efforts. In Industry, in Agriculture, in Engineering, efforts are being made to come into line with the progress that is obtaining in other countries. In medicine alone, it is unfortunate our people are ranged

between two schools of thought. One is for the revival of the old systems of medicine to be put on their former pedestal which some of the great nationalists think is the ideal thing to do as they honestly believe that nationalism means revival and consecration of the old heritage of the people of India. This view is shared by a large number of people both educated and uneducated and freely expressed everywhere from the platform and on the floors of the legislatures. The one theme of the song of these people is to go back to the days of old which were glorious. The other school of thought in the national renaissance is taking a stronger view and is quite inimical to the above mentioned outlook as it is convinced that to go back to the old conception of disease and its approach to treatment is fatal, uneconomical and dangerous to public safety. It also points out that we are passing through a phase in the evolution of human progress which is not narrow in its conception as all barriers of distance, time and space are overcome and contact with the outside world is a real thing. This aspect is illustrated by quoting the progress attained by the U.S.A., the U.S.S.R. and other western countries. These countries used to be devastated by famines and pestilences in the past; but now by adopting modern trends in medicine they have been converted into fruitful gardens ensuring better health and wealth for the people. These are held out as ideal centres of real and positive health. Industrial and Agricultural enterprise, building of big canals, irrigation and power projects have all been made possible by attention to preventive aspects of medicine more than curative. At present the national conception is to afford medical relief to the poor unfortunate people in the villages and urban areas in the cheapest possible way and in our anxiety to speed up the relief our bleeding hearts lead us to voice from the platforms that the western system of medicine is expensive and unsuited to the local people and therefore it is necessary to revive the old and simple medicine because it is cheap and effective and natural to the soil.

The simple medicines that are being advertised have not remained so simple. They are being exploited and kept a secret to the disadvantage of the individual concerned. They are advertised in full page colourful advertisements in the lay press with a view to sway the minds of the public. Some of the drugs attractively bottled and labelled are harmless and those that are harmful easily go out of the market due to medico-legal consequences following their use. In countries where Coroner's inquest system exists, it has an effective check on the sale of harmful drugs. A check is also found in countries where the Drugs Act is enforced vigorously as in America. Unfortunately in India these types of checks are lacking though attempts are being made to have an effective check.

In all basic sciences like Physics, Chemistry, Biology the outlook is universal. There is no such

thing as English Physics, Russian Chemistry and American Biology. Any advancement in the knowledge of these basic sciences that occurs is disseminated through lectures, essays, research papers, articles and books. Why should medicine alone be subjected to narrow parochialism when the benefits of medicine are universal?

In both ancient and modern medicine, when secret formulae form the bulk of medicine, they bring down the efficacy of the medical science and also confuse the minds of the lay public. To remedy this defect, the Mother of Parliaments set up a Commission with regard to the advertisement of patent medicines in the lay press. A Select Committee was set up in 1914 which arrived at definite conclusions which could not be effectively put into action. It was the lament of PROF. CLARKE, the noted Professor of Pharmacology, that even the House of Commons could not push through any legislation due to vested interests. Newspapers derived a large income from these large scale, prominent and attractive advertisements. Such advertisements offer sufferers from all and sundry diseases, miraculous cures, offering beans, tablets, wines, salts, powders, pills, ointments, hormones and gland extracts to reduce weights, to slim or to increase fat, to increase stature, to restore youth and sex potency, to dissolve stones in the gall and urinary bladders, indigenous Rasayanams, Lehyams and Makharadwajas. In short from a common cold to a child birth such fantastic advertisements are found to sway the minds of the gullible public, who buy these medicines more often imagining ills by reading the advertisements. If it is difficult in Great Britain to initiate legislation it is more difficult to legislate in India where different systems of medicine are practised without any control. However as a result of agitation in Parliament about patent medicines, one thing evolved in Great Britain, namely, that the cures for cancer and for venereal diseases were prevented from being advertised in the lay press.

Homœopathy and allopathic systems have standards abroad and it is the scientifically trained doctor who practises them. But in India Homœopathy is practised by all and sundry who become doctors of Homœopathy by reading books, or get spurious diplomas by correspondence without any basic knowledge of physiology, anatomy and basic sciences. Ayurveda and Unani have degenerated to quackery. Though there are savants in this line, this system has unfortunately been practised by quacks who through ignorance give not only wrong drugs but also dangerous drugs, imperfectly manufactured causing severe symptoms, sometimes with fatal results. This statement is made not as a frivolous attack on the indigenous system but to focus the attention of the public that it is necessary to bring order out of chaos.

Medicine should not be confused with mere drug administration. If it is the conception that drug

administration is medicine, then the whole argument for the rejuvenation of ancient medicine falls to the ground. If it is considered that medicine is progressive and advancing with the knowledge of ancillary sciences then the indigenous system of medicine should be brought into line with this ideal. The discovery of X-rays and Radium has led to the improvement of the diagnostic and curative aspects of medicine with which every person is well acquainted. The discovery of gases and other chemicals has led to the solution of anaesthetic problems and cure of diseases. The discovery of circulation and its publication in the year 1628 by HARVEY has led to a clearer conception about the vital fluids circulating in the body and many physiological problems based on the chemical constitution of the blood have been clarified. The evolution of blood transfusion may be stated to be entirely dependent upon this knowledge, though great strides occurred in the knowledge of the science and art of blood transfusion in recent years. The birth of Biochemistry has great potentialities and has already cleared many of the problems with regard to the body fluids both in health and disease. The discovery of the chemical composition of the crystalloids, colloids and vitamins is an example of the progress that medicine has made entirely based on the ancillary sciences. The pathological aspects of cells, cell lesions and environmental changes were all made possible by observations of biological aspects of the animal kingdom. In recent times chemotherapy has come to the forefront. The discovery of Penicillin has opened out new fields of thought. If Penicillin had been kept a secret then this drug would not have attained such efficacy as it has done now. By a lot of experimentation and extensive trials its usefulness has been established. A lot of time and money had been spent before its usefulness for the treatment of very serious conditions was found out with immeasurable benefit to humanity. Similarly new biological drugs have come to light and the literature that has grown round this subject shows the amount of critical survey from all angles with the sole object of attaining progress and also for probing into the possibilities of finding better and more potent and less harmful substitutes in the cure of severe diseases. This discovery of Streptomycin and the research to find out the scope of its use is another illustration. Thanks to research, it has been made possible to get purer Penicillin at cheaper rates.

Hormones and their manufacture in test tubes Insulin and its manufacture and use for diabetes are landmarks in the progress of pharmaceutical preparations.

The future of medicine depends upon a clear conception of the preventive aspect of medicine which brings positive health and is more beneficial to humanity than mere cure of diseases by bottles of medicine. At present there is a big race in

India and various systems of medicine are competing with each other. It has become a problem as to which bottle of medicine we are to dole out to the poor, ignorant, and helpless public. Is it the Allopathic, Ayurvedic, Siddha, Unani or Homoeopathic bottle that has to win the race? I hope our National Government will enunciate a new motto and a new principle. The outlook of a beneficial National Government *should be not to give a bottle of medicine but to give a bottle of good health.*

The belief that *Ayurveda* is "revealed" and cannot be bettered will be disastrous in the extreme. If *Ayurveda* is to be put on modern lines, we cannot think of doing it except by adopting modern trends of physiology, biology, physics and chemistry. It would be disastrous to think that Malaria is caused by humors and not by parasites. History tells us of the sacrifices made by medical men to learn the truth about Malaria. This has helped in the progressive development of preventive and curative medicine. The modern development of chemotherapeutic cures is an interesting phase and is an example of the value of developing medicine on scientific lines. The discovery of Atebrin, Paludrine, etc., are examples of the value of adopting modern ideas. More may be said of many other diseases which are devastating the countryside but which can be controlled by preventive and curative methods.

Such of the formulae and principles in the indigenous systems as do not come into line with modern medicine must be discarded and only those that can be utilised with advantage can be used for the benefit of humanity with more emphasis on the preventive aspects.

It is not the intention to decry our old system of medicine. It may be boldly stated that Indian Medicine and Indian Surgery at one time were far ahead of other countries which were practising medicine at the time but due to circumstances mentioned before they had fallen on evil days.

### Medical Relief in Villages

*Ignorance and superstition* are the predominant features of village life. To begin with, concerted action is necessary to improve this condition. Basic education, economic welfare and medical relief must work co-operatively.

In villages, people do not usually suffer from diseases which are common in urban areas. The smoothness of life is disturbed by epidemics, and quarrels which end in stabbing and murder. Traumatic accidental conditions also disturb the peace to a small extent.

For this there must be a co-operative credit society of brains with good financial backing. The hub of the society must be a P H man who should be the friend, p

guide. He being the most educated man and having an insight into the human ills and welfare may be the cortex controlling the whole of the machinery. This Public Health Officer must be trained in the following subjects—rural hygiene, mental hygiene, school hygiene and St. John Ambulance work (advanced type in its practical application).

It is my experience that the fundamentals of all aspects of medicine and surgery have been well brought out in essence in the small books of the St. John Ambulance Association, called "The First Aid to the Injured" and "Home Nursing." The basic knowledge contained in these books can be taught to the public to avoid calamities. It is the first right step in the direction of medical relief. The Public Health Officer must be a person interested in this aspect of medical relief. He should be able to improve the scope of public health activities by training people in St. John Ambulance work and to attend to the sick and the wounded and transport them to the nearest centre where proper treatment can be given. The post of the Rural Medical Practitioner as it exists at present is not satisfactory. He is ill equipped and has little knowledge of the practical aspects of dealing with emergencies and he finds his primary role is to dole out medicines. The Rural Medical Officer should be a preventive officer and not a curative one. It is unfortunate that in our country the popularity of an institution is judged by the number of outpatients and not by individual attention that we are able to pay to each patient. This necessarily swells the number of chronic cases that seek advice from day to day. This system should not be an index of efficiency of the institution. The yard stick of the measure of efficiency should not be by the large numbers of attendance and requires a changed angle of vision. It has been my experience that it is not possible for the admitting staff to see a large number of cases in a short space of 2½ hours. It would be necessary to gauge the efficiency of the medical officer not by the total number of outpatients he treats but by the attention he pays in reducing the number of chronic cases attending the institution by specific attention to certain diseases which are preventable by nature. The Public Health Officer being well acquainted with the field work of his department will exercise the necessary drive through his sanitary squad and organise a good medical relief. The villager is always grateful when he sees that he has been attended to with promptness and care during his illness and when epidemics are controlled in quick time or when he has sustained an injury he receives efficient first aid and is later transported to a surgical centre. Such news of good acts will spread like wild fire very quickly among the villagers and the medical relief becomes popular and effective and the objective of disseminating knowledge is gained.

Groups of villages must be tacked on to centres with facilities for treatment of surgical, medical

and midwifery cases. The taluk headquarters hospital will serve this purpose. A motor ambulance must be attached to this centre to be utilised on requisition for transporting patients from villages where there are roads and if after receiving the case the Medical Officer finds it difficult to treat, he must direct the case in the same ambulance to the district headquarters hospital. The Public Health Officer must be in charge of the taluk headquarters hospital. He must be trained in rural, town and school hygienics. If there are many schools more than one public health officer is necessary to assist the chief officer. He should be given the duties of teaching the students "Hygiene" by the Socratic method so successfully employed by Mr. BRAYNE in his village uplift. He should also train students in ambulance work. The woman Medical Officer, Health Visitor or attached nurses should serve as teachers in Home Nursing to the girl students in addition to their duties. To my mind the teaching of Hygiene, St. John Ambulance work, Red Cross and Home Nursing must be taught at the school level, and must be a compulsory part of the programme and if this is done the children when they grow up will know the value of hygiene and how to protect themselves when they are in difficulties or in danger. This is the best method of making people conscious of the evils of all medical ills and prevent them. Confucius, the Chinese scholar and statesman, has stated in his "Wisdom" that the best method of Government is Government by music and while enunciating this policy he has made remarkable reference to the following points. He has stated that—

- (1) if there are more policemen, there is no liberty ;
- (2) if there are more soldiers in the country there is no peace ; and
- (3) if there are more lawyers in the country, there is no justice.

I wish to add one more to the above and that is, if there are more dispensaries there is no health in the land. At least there must be one Public Health Officer wherever there is a school of 500 pupils. The Public Health Officer may act as the Director of the School systems at taluk levels because he is better educated than the average village school master. This is the cheapest way by which medical relief can be promulgated.

#### Ambulance Training for Medical Students

Every Taluk Headquarters and District Headquarters Hospital which are envisaged as secondary and District centres in the Bhore Committee's report should have specialists on their staff, more especially in traumatic surgery. It is worthy of note that there is no ambulance training given to medical students. It is well known that the correct

method of transport of patients and the correct methods of first aid to the injured are factors that help in reducing the loss of life and limb. In the scheme of medical education, I am sorry to observe, that this aspect of the training has been entirely neglected and this defect should be remedied. I suggest that the student may be given an insight into this aspect of training when he is learning anatomy and physiology and it will be a good step in the right direction to direct the attention of the medical student of preclinical period to traumatic surgery. This training must be made part of the college discipline. The teaching must be made more interesting by constantly bringing to their minds the fundamental principles of anatomy and physiology in relation to the traumatic and other conditions. Naturally, people who have had ambulance training will deal with traumatic conditions and emergencies efficiently in their practice and will probably become the nucleus of centres of ambulance organisation wherever they go. How often have I noted as an examiner that the medical student while he can talk on advanced aspects of surgery is unable to correctly adopt the method of first aid. One of the Brigade Officers (non-medical) of the IV District of the St. John Ambulance Organisation in Madras boldly asserted that in a competition the medical students will find it difficult to compete with the lay members of the Brigade in ambulance work. This statement appears to be genuine and real from the experience of the competitions and I see no reason why our medical students cannot come up to the level if in the earlier part of the medical training they had a sound ambulance training. The defect lies in our teaching.

### Brief Historical Background of Surgery

The practice of surgery as an art dates from the pre-historic times. Past excavations at Ur throw very good light on the surgery of the time in the Summerian period. Recent excavations may throw more light about the surgical aspects during the same period.

The recent excavations in Egypt and the discovery of Papyri popularly known as Edwin Smith Papyrus and Papyrus Ebers throw more light on surgery as practised in Egypt between 2000 to 1000 B.C. In this period the Exorcist came first, the Physician second and the Surgeon third in popular estimation. It is possible that the type of surgery practised in Egypt was the same as in the Summerian period. So far as India was concerned there is definite evidence indicating the practice of this art in the Rig Veda (4000 B.C.) and in the Atharva Veda (1000 B.C.) and there is clear evidence of slight traces of experimental surgery which were soon destroyed by a luxuriant growth of charms and invocations. The Brahministic period taught that it was pollution to touch a human corpse and thus prevented any study of anatomy

and the student was shown how to make incisions on fruits and punctures on bladders. Scarifications were demonstrated upon stretched skins; venesection on lotus stalks; the opening of abscesses upon a lump of wax smeared over a piece of wood; bandaging on a clay figure and cauterising on a piece of meat; in spite of these, there were attempts at resuscitation of this art. Cupping and bleeding, operations for stones in the bladder, complicated plastic operations were practised and couching of cataract was done on a large scale. CHARAKA and SUSHRUTHA, were the classical savants of the Buddhist period. They are credited with operations on the intestines and with Rhinoplasty. The surgery they did was far in advance of the times and they were good exponents of surgical skill of that period and the instruments evolved by them compare favourably with modern instruments.

Foundations of scientific methods in western medicine were laid by the Hippocratic School and continued by the Roman School of which evidence is exhaustive in the museum at Naples. Surgical instruments designed for a variety of operations resemble the modern instruments.

The work of CELSUS (25 B.C. to 50 A.D.) and GALEN (130 to 200 A.D.) showed the part played by the Greek medicine in the Roman civilisation and this was continued by the Arabians. It was GALEN who severed the spinal cord in animals and did the first experimental observation. The first hospital was started in Baghdad. RHAZES (850 to 923 A.D.), ALBUCAISIS (936 to 1013 A.D.) and AVICENNA (980 to 1036 A.D.) were the illustrious men who brought glory to Arabic medicine and probably this gave birth to the Unani medicine the term Unani meaning "Greek".

The Japanese also followed the methods of China until about 1871 when they broke away from the old traditions and forged ahead and were soon in the van guard of surgical progress.

Surgeons found their profession widely separated from medicine and in the 12th century A.D. this art was practised only by a few. Even the Universities of the time grudgingly licensed the practitioners in the art of surgery and more often with a proviso attached "so long as he does not practise medicine."

Until the 19th century, the story of surgery which was practised by a few people remained obscure. Heavy mortality and painful procedures drove fear in the minds of the public. It was revolutionised by the bacteriological discoveries of PASTEUR and the practical utilisation of this knowledge by LORD LISTER. The discovery of anaesthesia further helped the progress of surgery.

The sudden upheavals of progress of this art and science synchronised with wars. In our own times we know the contributions to the advancement of

surgery as a result of two wars. Older generations operated only to save lives sacrificing limbs, later ones to discover the causes of disease and its complications and operated to save life and limb. It is hoped that the future surgeon will operate only on animals to find out the cause in order to prevent wide and unnecessary surgical procedures.

This retrospect of the evolution of surgery has been given to bring home that this advancement would not have occurred had people complacently said that all that was done in ancient medicine is final. It may not be out of place to state here that when LORD LISTER introduced his antiseptic methods in surgery, other surgeons of the day laughed at him and his methods and continued to operate, with oldest filthy coats reeking with smell of blood, with needles stuck on to the lapels of their coats with disastrous results and would not even have the courtesy to look into the ways which LISTER employed to solve the main scourge of surgical complications, viz., hospital gangrene.

It was only when continental surgeons practised and advertised the value of his methods, his compatriots began to hail LISTER as the saviour of mankind. More than 70 per cent of the cases operated upon died before the introduction of Listerian methods. This state of affairs however changed with the introduction of antiseptics by LISTER (1829 to 1912) and with improvements effected by surgeons who followed in his footsteps.

The introduction of anaesthesia also contributed in no small measure to the advance of surgery and to the reduction of mortality. In modern surgery, the aseptic concept which has completely replaced antiseptic one has made it possible for surgery to find its beneficent sway from the extremities to other regions of the body. Nowadays every part of the body or organ is fearlessly attacked by the surgeon's knife; the brain, the skull, the spine and the spinal cord, the eyes, the nose, the ears, the throat and the lungs which are the guardians of our life, are restored to the proper functions; the pleura is drained, parts of the diseased lobes of the lungs are removed; the thoracic cage is collapsed; the heart is sutured; the broken arteries and veins are anastomosed; the ovaries, the uterus and the prostate are removed, the stomachs are opened and excised; and the intestines are repaired, resected and anastomosed. Wide and successful operations are performed for cancer with relief and prolongation of life. The congenital or acquired deformities are restored to normality by plastic surgery and the cripple problem is being solved. Compound fractures are turned into simple ones, and refractory bones are wired, plated, grafted and pegged. Joints are opened, cleaned, reconstructed and transplanted and thereby limbs are saved. Lives are saved by the transfusion of blood, and the grafting of organs like the testes, the ovaries and the thyroid is no longer considered to be an impracticable proposition. It would be sheer waste of

time, money and effort to revive the old system of surgery.

### Suggested Scheme for Investigation of Indian Medicine

Reformation in Indian medicine should be first directed towards research in drugs and specifics for diseases which are freely advertised, so as to select the useful medicines and discard the useless ones. It is suggested that it would be necessary to have a central institute of research department attached to existing medical institutions.

In Madras, there is an indigenous school of medicine now being formed into a college, where students are trained to be practitioners in both western and eastern systems of medicine. The basic educational qualification of these students is not satisfactory to enable them to understand the ancillary sciences which are the foundations of the modern system of medicine.

In Madras, the alumni of the same school, engineered several strikes on the ground of insufficient teaching facilities afforded to the students. It becomes obvious that if an unbiased investigation is undertaken, the school which has been in existence for over 25 years has failed to build up the teaching standards even though adequate opportunities were provided to the school. This shows that there is something definitely defective in its organisation and the intrinsic worth of the type of medical education that has been adopted in this institution. The following scheme is recommended to rejuvenate the ancient medicine and bring it into line with modern trends, with the following staff for the research department.

(1) Well trained physician of a professorial standard in modern and scientific lines and very eminent in diagnosing diseases with a good knowledge of Sanskrit.

(2) Eminent indigenous physicians of various systems.

(3) A brilliant chemist with a team to bombard the molecule of certain drugs which are considered efficacious.

(4) A pharmacologist with leanings towards research.

It is well known that there are some specifics advertised freely but the composition and formulae are kept secret. There are also some unexplained aspects of control of metabolism by will power, Hata Yoga is an example. What would be a happy method is for the clinician trained in western standards to diagnose the disease. After diagnosis a series of cases should be handed over to the expert indigenous physician who has these specifics. The western trained clinician and the indigenous physician will maintain records correctly in their own way. The treatment should be carefully watched day to day, week to week and month



o month and impartial observations should be made on the progress, actuated by a pure motive of research without any ill feeling or animosity to any system of medicine under investigation. The western trained specialist must be a conscientious person prepared to say the truth even though it may not be palatable to the modern system or the indigenous system. It is unwise to waste our time, energy and money in adopting CHARKA and SUSHRUTHA technique in surgery to-day but it would be interesting to know in more detail what our ancients did. In progressive thinking a historical background gives a better perspective.

PANDIT NEHRU, GHAZNAFAR ALI KHAN and DR. T. S. S. RAJAN have stated that it is necessary to review the ancient medicine in the light of modern scientific knowledge—a view held by all scientifically minded people. Clear thinking is necessary and the aim of the politicians and medical men should be to build up medicine suited to our conditions not by manufacturing different kinds of practitioners but by building up a synthesis of all aspects of medicine into one. What is good in the past, can be added to the existing knowledge. It would be a great day when a research institution of this type is started to delve deep and unearth the truths of our ancient medicine. Such a research institution will necessarily attract all types of men interested in medical relief and the scientifically proved indigenous system of medicine would be raised to the status of scientific medicine and thus it would come into line with modern trends in medicine. Such a synthesis would be an ideal to be aimed at. It must be the aim not to manufacture more ill qualified practitioners and let them loose on the public.

Everybody is eager that we should send medical relief to the villages. It is unfortunate that when the question of medical relief to the villages is being considered we are prepared to send all types of men without a sound medical education. We may ask ourselves, "Why should we send such ill qualified men? How are the lives of the villagers cheaper than those living in the cities and urban areas?" It is all the more necessary to send efficient men to the villages than to the cities or the urban areas. In the urban areas and cities the practitioners have the benefit of surgeons and specialists to guide them. In villages, they have no such guidance and therefore it is quite necessary to send trained men to the villages. To send inadequately trained doctors would not only be suicidal if it is the objective to wean the villagers from quacks, but in the long run would create a serious problem for any future Government to solve.

#### Medical Education

It would not be out of place here to discuss medical education in general and surgery in particular. We all realise that there is some inherent

defect in the present system requiring a lot of re-orientation and re-adjustment according to modern trends. Every teacher in medicine is aware that the curriculum is both heavy and in some cases unworkable. With the advent of specialities it has become more difficult to adjust the work of the basic medical student. It must be the outlook that we must take into account the ideal in spite of its past development, with the changing social and economic and scientific conditions of the present and the future. I have already shown the evolution of medicine in general, its trials, tribulations, successes and failures of the past, and it is but right that we should concern ourselves with the improvement of the conditions that exist at present with an eye for the future.

India had a glorious past in medicine. The western methods of medical education which are now accepted as the scientific system were implanted on our soil by the East India Company Government. The sole object of starting this medical education was to develop a subordinate staff to help the protagonists of these sciences to carry on their work smoothly. The outlook of all the people who had the benefit of this education has been changing. In recent times as in our aspirations for political independence, there has been a definite trend to improve medical education and medical relief. Various societies have been founded to better the medical standards of education and thought and such a move was taken by the Surgeons in the formation of the Association of Surgeons of India and it is but natural that we should review our past standards, critically review the present system and propose improvements for the future. The present system, thanks to the independence of the country, will have to adjust itself to the altered conditions and the medical profession should educate the public to cure this split mind that exists in medicine. There are no two opinions about medical relief. Though all medicine is one, the methods of approach towards the attainment of its perfection are varied and it is but right that in this age of ours we should synthesise our medicine and bring it into line with scientific trends. The system of medical education is being brought to a uniform standard and a research outlook is taking hold of the younger generation fired with the ambition to keep abreast of the outside world. With the awakening of the political consciousness the Government must give a momentum to advancement. It is but right that we should point out to the National Government that we are one with them in the attainment of independent ideals as much in the field of medicine as in others and the objective can be gained by researches into the past, stabilisation of the present, in our medical education this aspect has been entirely ignored and for reasons well known there is a gulf of difference between the ancient and modern medicine, modern ones knowing nothing about the ancient and the ancient medi-

cine knowing nothing about the modern. Is it not time that we should bridge this gulf and have a really scientific approach with researches in this aspect of medicine? Researches not based on ancillary sciences would be defective and barren. The first essential that we have to foster is a research department in the collegiate institution or start entirely self contained research institutions for this purpose and not start imperfect colleges of indigenous medicine producing graduates or licentiates to practise. *Sentiment should not outweigh reason and later be faced with a problem of caste which would be difficult to get rid of.*

We have only to refer to the valuable information given by the Bhore Committee which has tried to collect this in the shortest space of time. The existing scheme of medical relief has been carefully scrutinised and a plan set out for the future. If the Province should adopt this excellent direction with suitable alterations to suit local conditions, the future of medical relief would be put on a very sound basis.

It must be well within the knowledge of every teacher in the college that the majority of the students in the colleges are satisfied only with snap shot impressions of cases seen by them. During their junior clerkships, the main defect in education is the lack of liason between the professor and the taught with the result that the students get a variety of ideas pumped into their exhausted heads and sometimes in the same institution different and diametrically opposite views are stressed and pumped into their minds. These are not based on researches or experience gained by follow-up of cases but gathered from thoughts of other men with the result that the students suffer from split minds in medicine. They begin to wonder whether what they are seeing is really useful. If an unbiased investigation is made we will find that there is no co-ordination of teaching work from the start to the finish. Anatomy is taught for the sake of anatomy and not with the objective that it is useful for the student in his future study. After the examination in anatomy, the student safely forgets the fundamentals of anatomy. Where then is the defect? Similarly with regard to other ancillary sciences. The defect is both in the teacher and the taught. The selection of candidates for teaching is not ideal and probably you will all realise as I have that it is too much to expect that a student who has been brought up from his infancy in conditions of life and thought grooved into a definite channel, to suddenly change his trend of thought. The whole system of education must be looked into. It is distressing to realise however that many elementary schools, high schools and college limit their studies to a mere passing of the examinations. No independent thought is cultivated. The children accept such training with little question and in India the general knowledge of a student is so colossally poor that it is no wonder that he has not pro-

gressed to the required extent. Introversion is the main drawback of an intelligent child in India. We have been brought up in this way but with the changed outlook let us hope that the child will be an extrovert, more interested in doing things and becoming effective in what he decides to do than in himself.

It has impressed me profoundly that by observation of my school mates, college mates and children and my own children that most children make excellent beginnings, but as some of them advance through school, their curiosity and imagination gradually become blunted. They may go to professional college some of them lack a genuine vital and compelling interest in what they are studying. Their attitudes are passive rather than active and their success is chiefly due to their good memory. This seems incredible and in every college, there are many students under the present systems of qualification for promotion who meet with the requirements of degrees but who have lost that fresh and insatiable curiosity and imagination with which they started out in life. It should be the mission of education at every level to stimulate and constantly nurse the curiosity and imagination. With this outlook, education can be fruitful; otherwise it would be barren.

Progress in medical education and science depends upon the students' freshness to retain the vital impulses of curiosity and imagination throughout their lives. There is good reason to suppose that some of the present methods of formal education blunt rather than sharpen these essential qualities and I do hope that the National Government's policy will be to correct this defect.

It would be an eye opener if we take an actuarial study of all students who enter the portals of a college for a study of their career, the financial embarrassments the student suffers from, the environmental conditions influencing their career. This study may tell us where the defect lies. The selection of teachers is far from ideal, and the number of teachers for training the students is also far from adequate.

A hungry mind is anxious to learn but a hungry stomach prevents it from attaining this object. In spite of this we must admit that the student population has done its best and it must be our objective to better their standards and aspirations. Any sound plan of medical education must embrace the entire educational experience from childhood to retirement from practice. It is essential to develop a comprehensive programme of health education for everybody, to broaden and deepen the cultural and scientific education of the college students, to adopt broader principles of preventive and social medicine in the programme of medical schools to co-ordinate and unify the whole educational process. This will produce doctors fully capable of assuming the obligations of responsible

citizens and of exercising leadership in solving problems of individual and community health.

The course of study in the medical colleges is prolonged and probably the students' minds are over burdened with facts more often without a practical bias. How often do we find in the class rooms and wards the blackboards are being frequently used for teaching purposes 'instead of studying the patients and observing and inferring from cases that are in front of them? This aspect necessarily leads the student to feel that it is not the cases that he has to study but it is the lore that is contained in the books and thus he ignores the ward work and concentrates his attention on the written words in books. I am sure a stabilised National Government will look into this question in more detail and more carefully into the aspects of not only medical education but education in general.

Thanks to the initiative of the present Minister of Public Health in Madras, the Hon'ble Mr. A. B. SHETTY, a conference of all shades of medical opinion was called by him and a special committee has been constituted to advise him on various aspects of medical and public health relief. Such a scheme may bear fruit if the Government accept the propositions put forward with a good financial backing up.

### Specialisation in Surgery

It would not be out of place for me to say something about specialisation. The general surgeon has held the field for a long time and is still holding it. Specialists have developed in certain lines in big cities where colleges exist and more specialists are demanded by the public in the mofussil areas. The development of specialists in surgery is entirely due to the General Surgeon's concentrated interest in a particular field of thought and this becomes quite plain in tracing the evolution of specialisation. It is after the training as a general surgeon he directs his attention to narrower spheres of activity for developing technical skill and for gaining wider and deeper knowledge of the narrow field. No doctor should undertake speciality unless he has had a foundation in general surgery apprenticeship to senior surgeons well versed in this art and science. Later he must divert his attention to a speciality. A perfunctory knowledge would not only be fruitless but criminal. It is within common knowledge that the practitioners in their struggle for existence finding it more difficult to make a living, resort to some specialities hoping that they may eke out an existence better than their neighbours but with what consequences it is easy to understand. Surgery is a hard mistress and unless we have a programme of study and apprenticeship surgery will not advance and at the same time will be a menace to public safety. Everyone of us must have come across the ill results of a general practitioner taking to surgery without his proper apprenticeship. The approach

to this problem should be to encourage the post-graduates who have definite leaning towards general surgery and spe specialities so that they may flower into surgeons and specialists. Their services should be utilised in the remoter parts of the country. Specialities in surgery have become so many that differentiation is going on apace in other countries though halting and slow in our country.

At present it is a notorious fact that even in the majority of district headquarters hospitals there are no qualified surgeons on the staff of the hospitals. The District Medical Officer is a general practitioner and sometimes shows a leaning towards surgery but without any foundation. It must be the aim of the Surgeons' Association to impress that the future surgical centres must have trained surgeons on the staff in the remotest parts of the country.

In the furtherance of this objective all clinical institutions must concentrate on the training of their assistant surgeons as surgeons and specialists. I have as a teacher three assistants and 3 post-graduates but have only one theatre available for 3 days in the week for operations. It is necessary to have a theatre system attached to each unit so that these may be made available on all the days of the week. Three days can be used for the operations and the other three days for special types of investigations and junior surgery. Everyone knows the time taken for special investigations with modern instruments such as Gastroscope, Cystoscope, Arthroscop, Peritoneoscope, Endoscope and every other special gadget. In the furtherance of this objective, the younger men must be given full facilities to use these instruments on a large scale for more efficient diagnosis and once they become adepts in the use of these special gadgets, their minds will necessarily be directed to special channels. Stimulated by the interest that he has taken in the use of a Gastroscope that person will necessarily be a Gastro-enterologist and a man who does cystoscopy on a large scale will turn out to be an Urologist. Once a junior has made his mark in the use of these instruments, the Professor will necessarily give more and more work to such a person who is worthy of his confidence. This is the real way to develop specialities and the aim of the Professor should be to direct the young men's attention in special channels and inspire them to do better work than he himself has done.

I agree with DEEVER who said about a Professor's qualifications "If he is the practical and efficient personality which he should be, he will certainly possess the proper sense of the value of team work among his staff. Imbued with the importance of training his young assistants in self reliance and independence of action he will delegate to them the daily routine and the less intricate problems of diagnosis and treatment. The

service of the master himself should be required only for supervision and consultation in the more unusual and serious cases. In this team work there also enters the interplay of art and science." The aim of a good teacher has been from time immemorial to produce his successors. When teachers forget this responsibility there will be stagnation. It happened in India in the past and should not happen again.

### Operation Theatres

It would not be out of place for me to say something about operation theatres and their construction as this has a bearing on the training of the future specialists. I hope I am voicing the feelings of all surgeons when I say that we are dissatisfied with the operation theatres as existing at present where we have to spend the most strenuous part of our lives. Apart from the inconvenience of humidity and various other factors, the number of theatres at the disposal of each surgeon is too inadequate especially in teaching institutions. The Surgeon has necessarily to work long hours as each operation takes time and the volume of work for each surgeon in these institutions is great as the admissions cannot be controlled and the staff is inadequate to cope with the work.

A lot of time is at present being wasted in between operations. The students crowd round the place fouling the atmosphere, with no proper arrangements for their accommodation and in a tropical climate working with closed doors and sterilisers working in the adjacent rooms, the temperature of the operating room necessarily increases and saps the life of the surgeon and is also one of the causes for adding to the dangers of severe operative procedures. It is necessary that the surgeons should discuss about the place of their activities and evolve a scheme. Firstly each surgeon must have a theatre system to suit him and it is my view that twin operation theatres with all the equipment and staff should be permanently attached. The theatre staff should not change and should be a unit by itself so that in a teaching institution the unit by working harmoniously will help the research outlook in surgery. At present, the theatres are inadequate, ill-ventilated, ill-lighted and ill-supplied with instruments and ill-staffed. A changed outlook is necessary. The dream of future theatres is to prevent overcrowding and this may be secured by the installation of teleprojectors to project the operations outside the theatre for the benefit of the students.

### The Theatre Nurse

The training of theatre nurse is a very important problem and more so in India. Our methods of treatments in surgery are changing from time to time. Newer techniques replace the old. More and more delicate instruments and gadgets are introduced in surgery. Accidents are due to care-

lessness on the part of the nurses and the other staff. Unless the question of nurses' training is taken into consideration it would be impossible to carry out all the advanced aspects of treatment. The theatre nurse is a very important part of the unit and how often in hospitals have you not found that the theatre nurses were not up to the mark and are a source of headache. But it must be said to the credit of some of the theatre nurses that once they undertook the theatre nurses' job they undertook the work wholeheartedly for the love of it. Sometimes the work is forced on them with the result that the work is badly done and it becomes the serious anxiety of the surgeon who is unable to rectify it because he is subject to administrative vagaries. It is essential that the theatre nurses should have a post-graduate training centre in theatre work and they must be specially selected. These nurses must be put on a better footing and emoluments than the ordinary nurses and must not be changed very often as it is being done now. The nurses should take an abiding interest in all the latest information about theatres and their management and it is the duty of the surgeon to impart to her the knowledge about the modern aspects of the operations, techniques and the apparatus used. I have found that if this scheme is adopted, not only does she take an interest in the cases but also takes care of the surgical appliances and valuable instruments which we have to handle thus increasing their longevity.

*Anaesthesia* has become a specialist department and I am glad to hear that an Anaesthetists' Association is to be formed to further their interests and I as one who started life as an anaesthetist in a general teaching hospital fully sympathise with their interests. The success of an operation and the smooth post-operative course depends upon a smooth and well planned anaesthesia as well as the skill of the surgeon. The status of the anaesthetists in our country is not honourable. They are ill paid and it is my opinion that they deserve better consideration. I think it is time we surgeons give up our superiority complex and consider them as responsible partners in our undertakings.

### Cancer Problem

The treatment of cancer has developed into a speciality. The outlook of a surgeon in this direction has also to change with modern trends in medicine. With the development of the knowledge of the subject one knows how difficult it is to manage this aspect of treatment and necessarily therefore we have to divide our work between radio-therapist, radiologist and the surgeon. The starting of the Radiological Association is of happy augury. Let us hope that the treatment of cancer which is imperfect due to the ignorance of the public and of the doctor and the difficulties the general surgeon has while tackling this problem may be put on a sounder basis by a co-ordinated

effort by all concerned in the war against this terrible disease. The magnitude of the problem of cancer in India is not quite obvious as authoritative and recorded evidence is meagre. It is therefore not possible to develop centres for diagnosis and treatment of cancer. It is essential that there should be a scheme for recording cases of cancer in each hospital, to diagnose it clinically and pathologically and maintain a register specially for this purpose. Most of the cancer cases are not admitted and are generally seen as outpatients as the majority of them are beyond all hopes of cure. If these cases are not recorded in a proper register it would not be possible to assess the incidence of cancer in any particular area. Such a scheme was put into operation by me personally with the result that I have been able to gather very valuable information with regard to certain aspects of cancer. This should be enforced in all hospitals and a regular scheme of recording thought about and instructions issued to all the hospitals to submit annual returns in a model form that has to be evolved. If this is done, it would be possible to assess the incidence of cancer and devise methods to treat this condition. It is essential then that we should have a cancer and sarcoma register enforced by legislation for each presidency which will be a compilation of the returns sent to the Surgeon-General. These statistical records will be invaluable for research as well as to devise methods for the treatment of this condition.

### Industrial Medicine

It would not be out of place to talk about industrial medicine as this may prove useful in solving some of the morbidity in industrial concerns.

In India there is no definite organisation with regard to medical relief in industrial concerns except that certain companies have gone out of the way to have their own medical arrangements. The development of an industrial physician who will be dealing with both medical and surgical diseases should be instituted by the National Government as labour, which is getting very restive, demands several rights without the duties attached to it and sometimes industry is handicapped on account of sudden absenteeism on flimsy medical grounds. It is necessary that industrial concerns should have doctors to supervise the health and physical condition of their employees when they are on their jobs, to examine them before employment, to prevent and control infectious diseases in the plant, to recognise occupational diseases and advise on their prevention, to treat plant injuries and occupational diseases and to inspect the plant and general sanitation, to study the plant processes and hazards so that they make recommendations for preventing disease. This comprehensive scheme must be enforced and medical men employed. In the long run it would be a great help to industry in preventing morbidity by attention to occupational and industrial injuries. The present arrangement of

attention of industrial injuries is imperfect and uneconomical and the treatment adopted for these injuries is definitely unsatisfactory. Obsolete methods are being emphasised even to-day and the low standard of surgical work that is done does not redound to the credit of the medical profession and the increase in the morbidity and compensation shows that something has to be done to devise means for curing this defect.

In educational institutions, the medical students in their courses of preventive medicine do not get an inkling of industrial medicine. It is essential that we should make a beginning in each teaching institution by having a medical officer who will form a liaison service between the industrial concerns who send their patients to the hospital and the hospital authorities. He will visit these various industries and will be on their panel for advice and treatment and also be on the staff of the hospital. With the knowledge gained he will be a valuable teacher to the medical students. Six demonstration talks on industrial medicine during their course of preventive medicine would be invaluable in the training of the medical student. This should not be a black-board demonstration and set lectures but should be clinical demonstrations with a limited number of talks on industrial medicine.

### The Role of the Pathologist in Surgical Teaching

In the whole scheme of medical study, in the development of post-graduate teaching and for research, the position of the pathologist must be clearly defined. I am afraid the progress in the achievement of technical skill in specialities has been slow. Though various causes are responsible for this, yet one of the main and important cause is that there is no co-ordination between the pathologist and the various other units to understand and interpret disease and investigate the failures after intensely technical operative procedures. Such a scheme of things has not been existent in the majority of the clinical institutions with the result that the relation between the pathologist and the surgeon has been only through paper transactions. If we want to make any mark in our progress, it is essential that the pathologist should be our guide, philosopher and friend and a merciless but fair critic without the poisonous fangs. This will help the advancement of surgery and at the same time add to the academic knowledge. Otherwise our technical skill will be merely devoted to bread-winning pursuits. It is essential that we should have for each clinical institution a pathologist of eminence to guide us in all our fields of work. It is also essential that the various units should give the necessary facilities and respect for the opinion of the pathologist to enable him to rise to the eminence he has to attain. Such a scheme of things will be twice blessed; it will bless the pathologist to get to know the clinical units in understanding the disease, and also the surgeon of

the unit to interpret the disease in the light of the knowledge given to him by the pathologist from a critical survey of the specimens removed and from the post-mortem findings of the operative procedures he had performed. I have benefitted immensely by such contact, which alas, have in recent times been less frequent since I had to attend to the administrative function of the hospital. The staff of the pathologist is so meagre and the strain we put on these is so great that often there has been friction between the two departments but we have not come together to solve the trouble by jointly putting forward concrete proposals to augment the staff. I know that even when proposals are put forward they are not considered but we must be persistent in our demands when we are sure of our aim in the scheme of teaching. There is always a reaction to any suggested improvement. I was told by my esteemed friend Dr. KHANOLKAR, a pathologist of eminence in our country, that one of the former Surgeon-Generals told him plainly that it is no use wasting one's time in research, because it is being done elsewhere. No wonder that we have not made any progress in spite of the wealth of material that is available but not utilised. A scrutiny and heart searching will tell us the true tale. Is it possible to get a move on? With a National Government to back up, it should be possible to forge new schemes of vital interest in medicine such as manufacture of drugs and appliances, assessment of ancient medicine, investigation of diseases which require solution by research, development of post-graduate teaching and provision of facilities in our country up to the standards obtainable elsewhere. At one time it was estimated that  $\frac{3}{4}$  million pounds was spent annually by the Indian students to get theoretical training in western countries. If parents could pool these resources and if all the facilities are provided here it would not only enrich our country with knowledge but also will give us self respect. When will the day dawn? Let us not wait for it but struggle to see it soon.

### Technicians

I wish to make the following observations which arose out of the difficulties I encountered while doing clinical research. It is essential for conducting clinical research that the records must be complete with all the necessary information. Students usually like to hear their Professors but do not like to make their own observations and record them on the case sheets, with the result that the case sheets are grossly deficient in the recording of necessary information. For this inadequacy there are three causes :—

1. Inadequate mental equipment of the junior assistants to guide the students in the observation, inference and recording of the fundamental signs and symptoms of diseases.

2. Lack of responsibility of the medical student to work without supervision. Lack of adequate

supervision due to insufficient staff gives him the latitude to write a few notes to throw dust into the eyes of the Professor, with the result that the post-graduate student is handicapped by the inadequate information in the case sheets. This is a very great handicap for clinical research.

3. There is another factor. Correct recording of reports of the special investigation is not made easily available due to various difficulties and from my talks with the pathologist, bacteriologist and the biochemist I have gathered that it is not possible for them to do this with the staff at their disposal. Therefore there is a lacuna in the clinical recording of the case sheets, due to want of regular and timely service between the different departments on the one hand and the clinical departments on the other.

Having been an assistant Professor for 7 years and a Professor for over 15 years and having worked as a Superintendent of a General Hospital for over six years and having attempted to do clinical research I have become more than ever convinced of this void. I therefore consider it necessary to have a liason service between these departments.

The acme of perfection of a clinical institution should be to provide immediate and proper medical or surgical treatments, with a bias for scientific investigation. It is quite possible to afford the necessary treatment on a clinical diagnosis but in a teaching institution, the scientific bias should be a predominating feature, e.g. if an acute abdomen is admitted for an inflammatory condition, it is necessary to investigate the blood picture immediately and having opened the abdomen, it is necessary to know the type of causative organisms by cultural methods to complete the records for future study. Examples of this sort can be multiplied. The teacher of medicine is peculiarly confronted with lack of information of this sort when he wishes to talk to the students or post-graduates from his vast clinical experience. Hence he has necessarily to depend on information gathered from books or journals. The ideal of pathological service should be to provide facilities for collection of pathological specimens from the operation theatres and also for preparing frozen sections and furnish immediate reports so that surgeons may be enabled to carry out the necessary treatment especially with regard to certain type of tumours. At present, the pathological specimens are collected at the end of the day and sent through one of the toties or lascars to the bacteriology department and sometimes the surgeon finds that the laboratory is closed and the specimens are returned back. Sometimes the menial servants without knowing the value of the specimens, mix them up or lose some essential tissue which is vital for a diagnosis. To prevent such contingencies a new system has to be evolved by providing a liason service between the clinicians, the pathology and the bac-

teriology departments. Though it may not be possible to reach the ideal, I venture to suggest that a step forward can be attempted if trained technicians working under the bacteriology and pathology departments are attached to the Hospital, so that one man is always on liason service between pathology and bacteriological departments for each clinical unit if possible.

*What the Technicians will have to do is set out in detail below :*

**I. Bacteriology Department :—**The most important duty of the technicians of this department will be to assist the physicians and surgeons by providing the necessary material for cultural investigations. Under the direction of the bacteriologist, they have to transport the proper requirements of culture tubes and other materials for the clinical investigation of cases of medical officers. As it is necessary to carry out intelligent study to meet the requirements of the medical officers, there must be a man with a superior standard of knowledge of Chemistry and Biochemistry. The technicians for clinical institutions should be those possessing qualifications in Chemistry to take an intelligent interest in the work and not to work mechanically as it is done at present. There is inordinate delay and several investigations cannot be done for want of sufficient liason service between the bacteriological department and the clinical departments of general hospitals. For want of sufficient operation theatres, it is not possible to do septic cases except after completely dealing with the aseptic cases. These cases usually are done at the fag end of the day's work. This has been going on for a long time and requires re-adjustment and reformation. Building more operation theatres will speed up the work but cannot be given effect to for a long time to come due to the present prevailing conditions. When specimens are sent from the septic cases to the bacteriological laboratory, some of the causative organisms die during transit due to atmospheric conditions. Sometimes the department is found closed with the result that no bacteriological investigations can be done. As more emergencies occur at night it is more essential to have a staff for emergencies. Cases of Diphtheria, coccal infections acute inflammatory conditions of abdomen and similar acute conditions are attended to at night and the bacteriological picture is often lost. The patient is treated without scientific advantage to the clinician, to interpret the true pathology caused by the organisms that produced the disease. It is for this purpose that there should be technicians to work by day and by night and always available in the clinical laboratory attached to the hospital. If this is done, it will help the teacher and the taught to get the necessary inspiration from their own records.

**II. Pathology Department :—**This technician will serve as a liason service between this department and the clinicians and will work in the pathology laboratory and should be able to examine blood smears, do clinical pathology and help in cutting

sections, in the temporary mounting of specimens taken by day and night, take down complete notes, transport them to the pathology department and obtain reports from there, and record them in the case sheets of the respective patients.

Paucity of beds affords a problem on the admission days of each Physicians or Surgeon. Sometimes cases which are of clinical interest have to be discharged to admit emergencies which are plentiful and thus we sacrifice valuable clinical material useful for instructional purposes so as to make room for acute cases. There are no annexe hospitals to transfer the chronic cases, attached to any of the clinical institutions. Overcrowding is a feature of general hospital where cases are admitted as they come.

There is no system of a waiting list as in British Isles regulating admissions. In Madras, patients from all parts of the Presidency seek admission when they find that the local treatment has not benefited them. Some of them are so poor and illiterate that it becomes an imperative necessity to admit them. This necessarily leads to overcrowding and has been a great strain on the medical and nursing staff and the resources of the hospital. Quick admissions and quick discharges are the rule, and the special reports are received after the discharge of the cases when the case sheets have been sent to the registration department. Special effort has to be made to enter the reports in the case sheets after calling for them from the registration department. But this is never being done as it involves time and special effort on the part of the medical officers who are already overworked. It also increases the work of the registration department which is poorly staffed and has to see that the case sheets that are sent to the departments are returned back. Sometimes the case sheets are lost. To avoid such a contingency, it is better to have a liason service and the technicians are the ideal persons for this purpose. In Great Britain and in America, technicians play an important role in the research departments and some of them have done very clever experiments and helped in bettering investigations. If it is the object in future to equip the institutions for post-graduate teaching, then I venture to suggest that it is desirable to have this scheme so as to enable the teachers to be conversant with their own clinical material and with the pathological details, instead of having to depend entirely upon thoughts gathered from books and journals. This type of teaching will be appreciated by the post-graduate students. To improve the scope of the post-graduate teaching as well as junior teaching for undergraduates, technical assistants should form a very important link and if their services are properly utilised they will be a great asset not only in the treatment of cases but also in the recording and interpretation of diseases.

I wish to make it clear that though the technicians will not be able to give the necessary reports immediately by night—as the reports have neces-



sarily to be given by a qualified doctor—at least instead of having to wait for a long time, the technicians will facilitate their early production. As it is, there is a great delay in the production of these reports. It will always be an advantage to the staff of the respective departments who are working shorthanded to have these technicians who will do the work pertaining to the hospital clinical units and will be responsible to them concerning the materials taken to and from the hospital. They will also be able to supply the necessary details of information which are so often perfunctory and lacking. The specimens at present which adorn the racks are blank without clinical or operation findings. What a technician can do can be illustrated by giving a simple example of a practical case. A case of cyst of the abdomen, subumbilical region, is operated upon in a child aged 2 years. This proves to be a congenital hydronephrosis. It is removed. This case requires the following attention by the technician.

(1) Examination of the fluid.

(2) Mounting of the specimen removed in the natural way it was found at the operation by distending it with formal saline solution to conform to the size found at operation.

(3) Take clinical notes as well as operation notes of the case carefully and help the pathologist and the clinician in mounting the specimen and place it in the museum.

(4) Help in section cutting, indexing, writing of the notes, transferring the notes from the hospital case sheets to the pathology department.

I can multiply such instances to show that such a system is not available at present. The pathology museum abounds in a number of specimens and in the majority of cases there is no data or clinical notes or histological appearances classified and indexed in the way it should be done and as it is done in their foreign countries and Universities, with the result that they are not of any academic or scientific interest from a teaching point of view. Though these specimens might adorn the racks, to my mind they are not helpful for investigations and reminds me of a second-hand book-shop. Valuable books may be there but they require painstaking selection.

As no medical man will be willing to do the work on the play and emoluments existing at present under the present conditions and as he will be more anxious to supplement his income by private practice, his interest in the work will not be so wholehearted and therefore I suggest that non-medical graduates be employed for this type of work.

A selection may be made from among the graduates with science subjects and these persons may be trained in special institutes, or pathological, biochemical and bacteriological departments of teaching institutions. They may be given a diploma at the end of the training and posted to the respective departments according to their diplomas, so

that they form one of the most important links in the chain of organisation for scientific investigations.

No research, whether clinical or basic, is possible without well-trained technicians, and I consider this is a vital factor in the whole scheme. Medical men who come as post-graduates come and go but the technicians should be the stand-by for the institutions for helping in the basic and post-graduate training of the medical student.

These personal observations are recorded to show how clinical research is handicapped at every stage with the result that for the volume of the clinical material that is available in India, the poverty of the clinical papers published stand out in relief and in my opinion is due to the operation of the several defects pointed out above. A young man who has a strong desire to do research when he finds difficulties at every step gives up the ghost and takes the path of least resistance.

### Research

Research is in the air. Everybody talks of research. Medical institutions have existed for 100 years and over but the research papers that have emanated from these centres are very few. Basic researches were carried on hill tops. When anyone thinks of research, it is always in terms of basic and ancillary sciences. I therefore wish to emphasise that clinical medicine should also be considered as a subject for research. I am glad the Indian Research Fund Association has stimulated interest in this direction. The Provincial Governments also will have to encourage research. In clinical institutions experimental research is very neglected. How often do we find nutrition being taught on the blackboards with no experimental or clinical data.

Our pathological museums are replete with specimens of various types in the advanced stage of the disease and the student is not able to appreciate the various changes that take place stage by stage in the organism from the start. Demonstration of specimens in the various stages of development of disease so as to enable the students to visualise the changes that ultimately lead to the destruction and failure of function with consequent damage to human organism is quite essential. It is hoped that in the future we will have experimental surgery and experimental medicine as active parts of a pathological laboratory where the under-graduates and the post-graduates will work and see for themselves the day to day changes that occur in the organism as a result of disease. Clinical research should go side by side with basic research. It is a well-known fact that many of the clinical institutions are grossly ill equipped with statistical records for post-graduates to study and carry out clinical research. It is time that we concentrate our attention on this aspect of records.

The guiding aim of research should be as enunciated by FRANCIS BACON:



"The patience to doubt  
Fondness to meditate  
Slowness to assert  
Readiness to reconsider  
Carefulness to dispense and set in order and  
hating every kind of imposture."

#### Appeal for a Post Graduate College

SIR HAROLD STILES when he went to Philadelphia in October 1921, speaking on the need of co-operative thought in surgery said before the American College of Surgeons—"The possibilities which your college affords for organisation and prosecuting a systematic investigation not only into immediate and end results of operation but also into the value of various other measures employed in surgical therapeutics are very great. With the machinery for organisation which your college possesses, the untold wealth of material at its disposal, and the reliable observations which could be guaranteed, I am convinced that America would again lead the world. Science is ever becoming more and more international. America has taken more advantage of this cosmopolitan spirit than we Britishers and in my judgment this is the main reason why the sceptre of surgery is to-day wielded by America."

If he had made this statement in 1921, it is more true to-day as we have learnt through our contacts with the various American hospitals in India during the war the perfect system that they have developed and the spirit of investigation even on the field. Such a system is worthy of emulation in our country and should be the ideal to be followed. America is leading the world in manufacture of drugs, appliances, medical education, and research. In surgery, it has become a place of pilgrimage. It used to be Vienna formerly. All the savants and skilful exponents of this art and science are centred in this country.

The material in India is extensive. There is no lack of intelligence. What is required is effort on the part of the surgeon and encouragement by the State and philanthropic individuals.

It is my earnest hope that some moneyed men may come forward as donors and start a post-graduate college. Bombay gave birth to our Association of Surgeons of India. Is it a mere dream to hope that Bombay may start the first post-graduate college and an efficient college of surgeons—Bombay, such a magnificent city with millionaires and multi-millionaires who, on many past occasions, have shown by their generosity that their outlook in life is not only to make money and make themselves happy but also to radiate happiness to those unfortunate people who are placed in poor circumstances. No better service, can be done to humanity than by starting such a post-graduate college for research and teaching which will make men efficient in the service of the public. As a result of this, may it be said that India in its age of independence is thinking aright and the public, the politician, the merchant, the land-owner, the millionaire, the scientist and the doctor have worked together for the common cause of further-

ing the interests of the Indian Nation so as to enable her to find a place among the nations of the world.

After the inauguration, the usual group photograph of the members of the Association was taken.

The first Governing Body Meeting, was held at the Physiology Lecture Theatre of the J. J. Hospital at 11 A.M., Dr. M. G. Kini presiding. 15 members were present.

Minutes of the last two Governing Body Meetings were read and passed. About 30 new members proposed during the year were duly admitted.

There was only one entry for the Prize Essay on "Surgical Aspects of Amoebiasis", and since the essay was not up to the standard, the Prize was not awarded. In view of the poor response from the profession, it was decided to drop the Prize Essay competition from 1948 onwards.

Discussion on the three main subjects, viz., (1) Bone Tumours, (2) Spinal Tumours and (3) Burns, fixed for the year were held in the afternoons of the 26th, 27th, and 28th December respectively.

The members visited the K. E. M. Hospital, J. J. Hospital, Tata Memorial Hospital and Wadia Children's Hospital, and had the pleasure of seeing Surgeons at work. Operations for Spinal tumour, Carcinoma of the Stomach, Adenoma of the Thyroid and Renal Calculus, etc., were among those witnessed.

A boat trip round the Harbour was arranged and every one thoroughly enjoyed the trip. The weather was ideal and every one was kept lively and entertained, thanks mostly to the efforts of young Vasant P. Mehta. The absence of the Annual Dinner was keenly felt, but this was unavoidable on account of the Food Control. There was, however, a Cocktail Party, which was well-attended and was a great success.

There were a few functions common to all the Associations and among them, a reception at the Harikishindas Hospital. This is a private Hospital and its size and equipment speak well for the Philanthropy of the rich men of Bombay.

A Meeting of the Editorial Board was held at the Tata Memorial Hospital on 28th December at 11 A.M., Col. Pandalai, the Chairman of the Editorial Board, presiding, and methods for improving the standard of the journal were discussed. The Meeting adjourned to 30th December at 10 A.M. for considering reconstitution of the Editorial Board.

It was decided at the Meeting that in future each member of the Board should procure at least two articles every year from his area and if he has not procured any article for two years consecutively, his name would be taken away from the list. Members would, in the first instance, see that the articles sent in were of the required standard. A Section devoted to periodic progress in different branches of Surgery was to be included in the Journal and for this purpose, every member of the Board should be requested to take up some branch of Surgery and review the periodical progress.

### The Annual General Body Meeting

The IX General Body Meeting of the Association of Surgeons of India was held on 29th December 1947 at the J. J. Hospital, Bombay, Rao Bahadur Capt. M. G. Kini presiding. There were more than 90 members present.

After the President's Opening remarks, Col. Pandalai made a touching reference to the tragic death of Dr. N. C. Joshie, a former President, and moved a resolution expressing the Association's deep sorrow and conveying to the members of his family its sincere condolences. The Resolution was unanimously passed, all the members standing.

The Secretary then read the minutes of the last General Body Meeting and the Annual Report for the year ended 31-12-47 and the audited Balance Sheet, etc., for the year ended 31-12-47, and they were passed.

The President read out the Nomination Papers submitted for the Presidential election. There were three names for the election, viz., Drs. S. R. Joglekar of Bombay, K. S. Nigam of Lucknow, and N. S. Narasimhan of Madras; Dr. Narasimhan, however, withdrew from the election. A Poll was taken. Dr. Joglekar secured 61 votes and Dr. Nigam 23 votes; two were invalid. Dr. Joglekar was declared elected President for the ensuing year.

### Amendments to Rules and Regulations

The amendments to the constitution were then duly proposed, seconded and passed by a majority of 2/3 of the members on the roll as required by the previous constitution. (A printed copy of the amended rules etc. will be posted to members as soon as it is ready.)

The Secretary then placed before the House the invitation from Patna to hold the next Conference of the Association there and it was provisionally decided to hold the 1948 Conference in Patna. It was not possible at that time to elect a Local Secretary, on account of the absence of members from Patna. Dr. P. Chatterjee of Calcutta informed the House, that in the event of there being nobody to do the work of the Local Secretary for the Patna Conference, he was willing to invite the Association to hold the 1948 meeting at Calcutta.

(Dr. U. P. Sinha of Patna has subsequently written to the Office saying that he is willing to be the Local Secretary for the Patna Conference in December 1948. The next Conference will, therefore, be held in Patna.)

Dr. S. J. Mehta and Dr. U. M. Rau then spoke eulogising the yeoman service done to the Association by the retiring Secretary, Dr. Menon.

The President in his concluding remarks expressed his appreciation of the way in which Dr. Menon the retiring Secretary had conducted the affairs of the Association during his term of Office. Dr. Menon replying, thanked the President and

members of the Association for the kind words and for the co-operation he had from the members during his Secretaryship.

He also thanked heartily the Local Secretaries Drs. Arthur DeSa' and V. P. Mehta and their Student Volunteers for their excellent efforts in making the Conference a complete success.

Soon after the General Body Meeting, the last Governing Body Meeting was held at the same place with Dr. Joglekar, the new President in the Chair. About 75% of the members of the Governing Body were present.

Dr. Menon proposed the name of Dr. U. Mohan Rau as the next Hony. Secretary of the Association and he (Dr. Mohan Rau) was unanimously elected.

With a vote of thanks by the new Secretary, Dr. Mohan Rau, the meeting terminated.

\* \* \* \*

### Subjects for Discussion

#### 10th Meeting:

1. *Intracranial Tumour*—  
Opener: Dr. A. V. Baliga, Bombay.  
Seconder: Dr. R. N. Cooper, Bombay.
2. *Talipes Equinovarus*—  
Opener: Dr. R. Kalamegham,  
Trichinopoly.  
Seconder: Dr. M. Bahadur Khan,  
Hyderabad.
3. *Surgical Complications of Typhoid*—  
Opener: Dr. V. G. Vaishampayan,  
Sholapur.  
Seconder: Dr. A. V. Baliga, Bombay.

#### 11th Meeting:

1. *Treatment of Elephantiasis and Lymph Oedema*—  
Opener: Dr. V. P. Mehta, Bombay.  
Seconder: Dr. T. Kanakaraju,  
Ramachandrapuram.
2. *Treatment of Hernia with Fascial Grafts and Silk Sutures*—  
Opener: Dr. P. Chatterjee, Calcutta.  
Seconder: Dr. S. K. Datta, Calcutta.
3. *Treatment of the Bone Cavities in Chronic Osteomyelitis*—  
Opener: Major D. K. Sabhesan, Madras.  
Seconder: Dr. B. N. Sinha, Lucknow.

#### 12th Meeting:

1. (a) *Bronchiectasis*—  
Dr. R. Mahadevan, Vizag.  
(b) *Lung Abscess*—  
Dr. S. J. Mehta, Bombay.
2. *Intestinal Obstruction in Children*—  
Opener: Dr. A. E. DeSa', Bombay.  
Seconder: Dr. R. A. Irani, Bombay.
3. *Sciatic Syndrome*—  
Opener: Dr. S. K. Sen, New Delhi.  
Seconder: Dr. V. P. Mehta, Bombay.

# THE INDIAN JOURNAL OF SURGERY

X

JUNE 1948

No. 2

## BONE TUMOURS

by D. R. MEHER HOMJI.

The subject of Bone Tumours is as interesting as it is confusing. We have greatly benefited in our knowledge of bone tumours ever since the American College of Surgeons established the Registry of Bone Sarcoma in 1921. In spite of the newly made advances, we have not always successfully handled these cases of bone tumours. This failure of proper management has been due either to the mistakes in the diagnosis or to the delays in the diagnosis. If success is to be achieved, then it is our duty to detect these cases early, to make a correct diagnosis and to institute immediate and appropriate treatment.

The general practitioner, who is a liaison between the patient and the specialist, in his course of practice comes across patients with symptoms referable to the skeletal system. It is to him that these cases present major diagnostic problems. These individuals are invariably treated for a long time under the mistaken diagnosis of Rheumatism, Sprain, Arthritis, etc. Obtaining no relief, they eventually find their way to the specialist after a lapse of valuable time. The general practitioner will do well if he keeps in mind the possibility of malignancy, whenever a patient complains of unexplained pain in the bone. There is no necessity for him to assume the responsibility for the diagnosis and the treatment of bone tumours. Whenever he comes across such problems, then, in the interest of the patient, he should consult a specialist or

refer the patient to specialised clinics for a thorough diagnostic investigation.

In the diagnosis of bone tumours, the clinician, the roentgenologist and the pathologist should work as a team, for it is only through their combined efforts and close co-operation that it is possible to arrive at a correct diagnosis. Each one of these should fully realise his own limitations. The clinician must be open to the merits of different methods of treatment. The roentgenologist, at the same time, must realise his short comings in the interpretation of radiographic findings. The pathologist should be fully aware of his responsibilities, for any error on his part, may lead the surgeon astray in the method of treatment.

The clinician should make every attempt to take the history carefully, especially with regard to the date of onset, the presence or absence of pain, the rate of growth of the tumour, presence or absence of fever and the relationship of trauma to the onset of symptoms. The physical examination also must be thorough and complete.

Pain is the most important symptom in bone malignancy and occurs the earliest. It is usually constant and progressive and is worse at night than on exertion. Swelling usually appears later than pain, increases steadily, but the rate of growth depends upon the nature of the neoplasm. Impairment of function is usually late in onset but may occur early. The relationship of trauma to the onset of symptoms and the development of malignant tumour deserves special consideration. The question of

\*Paper read before the IX Conference of the Association of Surgeons of India on 26th of December, 1947.

whether a malignant bone tumour was caused by the trauma is one which has been disputed for many years. Much can be said on both sides, but we have seen so many patients who have given a definite history of trauma located to the part before the onset of bone tumour, that it is difficult not to believe that trauma has something to do with the origin of the lesion. However it is possible that in many cases it is the trauma that first draws the attention of the patient to the disease. The roentgenograms must be taken carefully and require skiagrams in different planes and also stereoscopic pictures. X-ray studies of the chest should never be omitted as we are aware that the bone tumours in general give rise to metastasis to the lungs by way of the blood. It may indeed be necessary to study the X-ray pictures of the skull, pelvis, spine and other bones, particularly in cases of multiple myeloma. The roentgenographic examination gives us information regarding the architecture of the tumour and other associated features which can be made out on the X-ray film. Although various characteristic appearances of the different types of bone tumours have been described in text books and in the literature, our experience has convinced us that one cannot always make a correct diagnosis from radiographic

findings alone, though one can make a correct guess in a high percentage of cases.

Having satisfied ourselves that the case in question is that of a bone tumour from clinical and radiographic evidence, then there are other features which may help us in the diagnosis of the common bone tumours. This may be tabulated as in Table I.

It is said that the osteogenic sarcoma practically never metastasize in the lymph nodes. In our series, we have cases of osteogenic sarcoma of the upper end of humerus which have metastasized to axillary lymph nodes, and confirmed by microscopic examination.

The laboratory procedures are of great importance in the diagnosis of bone tumours. These consist of chemical, serological and histological studies. Blood counts and Wassermann Reaction should be done as a routine, sedimentation rate is also of value. The leucocytic count and the sedimentation rate are often elevated in Ewing's tumour. In the analysis of urine, it is necessary to test for Bence-Jones Bodies, when there is a suspicion of the case being a multiple myeloma. It is necessary to mention here that the presence of Bence-Jones Proteinuria is not diagnostic of multiple myeloma, for these bodies have

TABLE I

	Giant cell tumours	Ewing's Tumours	Osteogenic Sarcoma	Multiple Myeloma
Age	Between 20—40 yrs.	4—20 yrs. Infrequently observed after 30 years.	10—30 yrs. Also occur in the aged when associated with Paget's disease of bone.	Usually over 40
Location in Bone	In the Epiphysis	In the Shaft	In the Metaphysis	In the Shaft
Common sites	Commonly occur in the lower end of femur, upper and of tibia, lower end of radius, maxilla.	Commonly occur in the femur, tibia, humerus, mandible.	Commonly occur in the lower end of femur, upper and of tibia, upper end of humerus.	Commonly occur in the bones of the pelvis and femur.
Metastasis	Does not metastasize.	In the lymph nodes, lungs, skull, ribs vertebrae.	In the lungs, & practically never in the lymph nodes.	Skull, ribs, vertebrae & practically never in the lungs.

also been reported, to be present in lymphatic and myelogenous leukemia, metastatic carcinoma of the bone, fibrocystic disease, polycythaemia, comminuted fractures, senile osteomalacia and multiple sarcoma of the bone. Nevertheless the presence of Bence-Jones Bodies together with the radiographic evidence greatly helps in the diagnosis. The study of peripheral blood has been thoroughly investigated by Morristette and Watkins in cases of multiple myeloma. The significant findings as reported by them were: (1) anaemia, (2) excessive formation of rouleaux, (3) immaturity of both erythrocytes and leucocytes, (4) lymphocytosis, (5) eosinophilia, (6) the presence of myeloma cells and a typical plasma cells. The study of bone marrow by Sternal puncture is also of great value in cases of multiple myeloma.

Blood chemistry in recent years has found an important place in the diagnosis of bone tumours. In all cases, a routine study of serum calcium, phosphorus, serum alkaline phosphatase and serum proteins should be made. A high alkaline phosphatase is indicative of normal new bone formation, as in fractures, or when abnormal new bone is being formed in Paget's disease of bone, osteoplastic osteogenic sarcoma, or osteoplastic metastatic carcinoma. The study of serum acid phosphatase should be carried out if carcinoma of the prostate with bony metastases is suspected. In cases of carcinoma of the prostate with skeletal metastasis, a large amount of acid phosphatase is usually though not always demonstrated in the blood serum. Recently we had a case of carcinoma of the prostate with generalised skeletal metastasis, and the study of serum acid phosphatase failed to reveal even a slight elevation. Serum acid phosphatase is also elevated in certain cases of far advanced Paget's disease of bone, but in this condition, the serum alkaline phosphatase is present in extremely high levels. The study of serum proteins is indicative in multiple myeloma. In these cases, the serum proteins are elevated, and this elevation is

mainly in the globulin fraction. The normal albumin globulin ratio is completely reversed in the direction of 1 to 3 or even 1 to 6.

Finally the most reliable procedure that we possess in our diagnostic armamentarium is the microscopic examination of the tissue removed. Here we have two methods at our disposal, aspiration biopsy and incisional biopsy. There is as yet some difference of opinion as to whether a biopsy of bone tumour should be performed or not. The necessity for a biopsy becomes evident to anyone who comes across a large number of bone tumours in his practice. More often than not, the clinical and roentgenographic diagnosis is inadequate for outlining the method of treatment. The microscopic structure of the lesion also helps us in gauging the effect of the treatment in a particular case. The aspiration biopsy, in our hands, has proved an excellent method in establishing the diagnosis. The advantages of aspiration biopsy may be briefly mentioned here as cited by Snyder and Coley. It is a simple, rapid, economical procedure. It may help in proving the diagnosis in a questionable case, and in an obvious case, it provides an histological proof. The only hazard of this method is the difficulty of interpretation. It requires unusual skill and experience on the part of the pathologist, who has to give the diagnosis from a small piece of material removed or from isolated groups of cells. At the Tata Memorial Hospital, this procedure has become a routine in cases of bone tumours, largely through the close co-operation and skilful interpretation by our pathologists. The use of incisional biopsy is often considered dangerous in cases of bone tumours, as some are of the opinion that it may produce metastasis or give rise to infection and increase the rate of growth of the tumour. In general, it may be stated that this danger is overemphasized. We employ this procedure wherever the aspiration biopsy method has failed to give us a diagnosis. It is our practice to apply a tourniquet and meticulous care is taken during the performance

of an open biopsy. The wound is never packed nor drained, but closed in layers. If these precautions are not adhered to, then there are chances of fungation of the tumour through the wound, secondary infection and acceleration of the rate of growth. I may state here that we have had no untoward effects either from aspiration biopsy or incisional biopsy. Before aspiration biopsy is carried out, the site for the insertion of the needle and its direction is decided upon after studying the radiographic picture. The site selected is usually at a point where there is a breach in the cortical bone or where the tumour has extended into the soft tissues. The technique of aspiration biopsy has been fully described by Martin and Ellis. The aspirated material in the needle is then gently extracted by means of an obturator and placed on a glass slide. To obtain a smear, another slide is placed over it, and applying firm pressure, the tissue is crushed thin between the slides, and then drawn across lengthwise. The slide is then fixed and stained with Haematoxylin and Eosin and is ready for diagnosis in from 6 to 8 minutes. The smear method has the disadvantage that it destroys the architecture of the tumour tissue. During the past three years, we, at the Tata Memorial Hospital have elaborated a technique of aspiration biopsy which maintains the architecture of the tumour and at the same time does away with the so-called dangers of an incisional biopsy. We do not profess to claim any originality about this procedure, for it might have been done by others. In this procedure, the aspirated material in the needle and in the syringe is collected on a piece of white muslin cloth spread on a petri dish containing normal saline. The petri dish is then gently tilted from side to side in order to wash off the blood. The muslin cloth containing the tissue material is then immediately transferred to a porcelain dish containing Zenker Formal solution. The small pieces of tumour tissue immediately turn yellow in this solution. These are then collected in a colloidin sac

and are then carried through the process of paraffin embedding. The procedure for preparation and staining as carried out at the Tata Memorial Hospital has been elaborately described by Khanolkar and Nerurkar. The slide thus prepared is ready for diagnosis within 24 hours.

We have had 82 cases of bone tumours, of which 13 were benign giant cell tumours, 4 malignant giant cell tumours, 24 osteogenic sarcomas, 3 chondro-sarcomas, 27 Ewing's tumours, 4 multiple myelomas, 4 reticulum cell sarcomas, 2 lipogenic sarcomas and one haemangio-sarcoma.

With regard to the treatment, I shall restrict myself to the treatment of common bone tumours.

*Giant Cell Tumour* : This tumour can be treated either by surgery or by irradiation. It must be stated here with emphasis that either surgery alone or irradiation alone yields excellent results. Due warning may also be sounded here that the combination of these two methods is not to be recommended as this is likely to lead to malignancy. Coley and Higinbotham have stated that some of their cases in which this combined treatment was used, seemed to show such a clear malignant transformation from an apparently benign state that they discontinued this practice. They thus maintain that for reasons not clearly understood, curettage and X-ray therapy do not form a desirable combination in the treatment of giant cell tumours. With regard to the choice of the method of treatment, surgery is recommended for lesions which are easily accessible, especially those around the knee, and irradiation for lesions that are inaccessible, especially those in the spine, skull, pelvis and upper end of femur. If surgery is decided upon, then we have at our disposal, (1) curettage, cauterization and primary wound closure, (2) resection and (3) amputation. The procedure of curettage can be carried out in the majority of cases of giant cell tumours. The method of resection has been recommended for lesions situated in certain non-weight bear-

ing bones e.g. fibula, ulna, ribs, and also for certain small bones e.g. patella, carpal and tarsal bones. Amputation is reserved for cases undergoing malignant transformation, for cases too far advanced for conservative procedures, and in cases of lower extremity where a useless limb has resulted from surgery or irradiation, and where a better functional result can be obtained in cases of large tumours. Irradiation is as good a method as surgery, and excellent results have been reported in the literature with this method of treatment. In the irradiation therapy of these tumours, it may be stated that there is as yet no standard technique or dosage evolved. Some treat their cases with high voltage therapy, and some with low voltage therapy. Whatever the voltage employed, smaller doses are preferable, and it is beneficial to repeat the cycle less often or at longer intervals. The treatment with heavy doses at frequent intervals gives rise to a severe reaction which has been referred to as Herendeen Paradoxical reaction. The tumour increases in size in from 3 to 4 weeks. The skin becomes markedly red and oedematous, there is marked pain and tenderness, there occurs expansion and thinning of the bony cortex and the trabeculae become so washed out that there remains hardly any vestige of bony detail. The roentgenologist treating these cases must be well conversant with this phenomenon, and should not consider these occurrences as signs of failure. Masterly inactivity should be the rule during this period except that the limb be well supported. After these changes subside, pain and tenderness disappear, the swelling and redness abate, the tumour becomes firm, and if the X-ray pictures are taken during this period they will demonstrate signs of bone regeneration and calcification. Once these changes are taking place, it is best in the interest of the patient to withhold further irradiation. At the Tata Memorial Hospital, the irradiation technique utilised is as follows: 200 K.V., 0.5 mm. Cu. and 1 mm. Al filter, 50 cm. T.S.D. A dose of 200 r in air is administered to

each port for a total dose of 1200 r to 1600 r. Of the 13 cases of Benign Giant Cell Tumours, 4 were in the upper end of tibia, 2 in the lower end of ulna, one in the lower end of radius, one in the lower end of femur, one in the ileum, one in the upper end of fibula, one in the temporal bone, and two in the upper end of humerus. Eight cases were treated by X-ray therapy, 2 cases by resection, and 2 cases by amputation. One case had no treatment. Many of our patients were reluctant to subject themselves to surgery and hence were treated with X-rays. We are quite satisfied with the treatment by X-ray therapy and five of these cases have been followed up for more than two years. As an illustration, I shall briefly relate the case history of a 23 year old Hindu male (Case No. 354) who applied to us on 14-5-1941 with the history of injury to right knee two years ago, with immediate pain lasting for four months, and disability to walk for six months. About nine months later he developed a swelling in the region of right knee. A clinical diagnosis of osteoclastoma of the upper end of right tibia was made, and this was confirmed by radiographic pictures. Aspiration biopsy was reported as Benign Giant Cell Tumour and the patient was started on X-ray therapy, and a total dose of 1500 r was given to each of four ports. Thirteen months after the X-ray therapy the radiographic pictures revealed filling up of the trabeculae with dense bone.

With regard to malignant giant cell tumours, the method of treatment is radical surgery. We have had four cases of malignant giant cell tumours in our records and all have terminated fatally. A 24 year old Hindu male (Case No. 5343) was admitted to the hospital on 27-9-43 with the history of injury 15 months ago, on the outer aspect of the right leg just below the knee. Pain developed immediately. He noticed a swelling four months after the initial injury. A clinical diagnosis of Benign Giant Cell Tumour was made from physical examination. The roentgenologist's report was also Benign Giant Cell Tumour.

Aspiration biopsy failed to reveal any tumour material and a formal biopsy was performed and reported as malignant giant cell tumour (Jaffe grade II). Amputation above the knee was performed. A sinus persisted at the stump for six months. He remained well for 2½ years after the operation when he complained of pain and swelling of the stump and there was a granulation tissue like mass at the site of original sinus. This was biopsied and the report was malignant giant cell tumour Jaffe grade III. Disarticulation at hip was performed and one month later he developed pulmonary metastasis and expired two months later.

With regard to *Ewing's tumour*, radiation therapy is the treatment of choice. Although these tumours are highly radiosensitive, and disappear completely after irradiation therapy, they have the tendency to metastasize widely in the lungs and other bones, so that the ultimate outlook is a fatal one. We have had 27 cases of Ewing's Tumour, of which 24 were biopsied at our hospital. Of the 24 cases that were biopsied, 22 were reported as Ewing's. Of the 22 cases with positive biopsy, the diagnosis of Ewing's tumour was obtained by aspiration biopsy alone in 13, and all these responded to X-ray therapy. In 5 cases aspiration biopsy was not conclusive and in 5 of these the diagnosis was obtained by formal biopsy. Formal biopsy alone was performed in 5 cases. In one case, aspiration biopsy was reported as malignant tumour and later confirmed by a formal biopsy. In one case the formal biopsy was performed outside. Two cases were amputated outside, and the outside slides were reviewed by us. Of the 27 cases, 7 were in the femur, 7 in the tibia, 2 in ribs, 5 in the pelvic bones, 2 in the skull bones, 2 in the fibula and 2 in the humerus. Out of the 27 cases, only 19 were treated by X-ray therapy. Four of these died in the hospital. Of these four one remained free of disease for 2 years after treatment, one lived for 1½ years after treatment, one for one month after treatment, and one for 10 days after treatment. The rest were fol-

lowed for periods of 4 to 13 months after treatment and then were not seen, and are presumably dead. Here I would like to illustrate a case of 24 year old Christian male (Case No. 7361) who applied to us on 28-6-44 with history of pain in the right pubic region of 6 months duration, and a vague painless swelling in the same region of 2 years duration. He gave no history of trauma and walked with a limp for the past three months. Physical examination revealed an indefinite swelling involving the superior ramus of the right pubic bone. A clinical diagnosis of malignant tumour of the pubis of the nature of Ewing's was made. Radiographic studies revealed Ewing's tumour. Lung fields were normal. Aspiration biopsy confirmed the diagnosis of Ewing's tumour. Patient was started on X-ray therapy (3500 r to each of 2 ports). Patient responded to X-ray therapy, with complete disappearance of pain and swelling. Two months after treatment X-ray studies revealed formation of new bone. On 9-7-45 that is 13 months later, patient reappeared with pain in the chest and cough of 20 days duration. X-ray studies of the chest revealed bilateral pulmonary metastasis. He was treated with X-ray therapy with complete disappearance of pain and metastasis. He then developed metastasis to the left 8th rib on 29-8-45 and responded completely to X-ray therapy. On 23-4-46 that is 22 months after his first visit he developed metastasis in the right clavicle and on 10-5-46 he developed paraplegia from 10th dorsal downwards and died in the month of August of 1946. He thus lived for 26 months from the date of first application to the hospital and exactly for 2 years after the initial X-ray therapy.

In cases of *Osteogenic Sarcomas*, radical surgery is the only method of treatment, and this may entail amputation or disarticulation. The success of radical surgery mainly depends upon it being carried out in the absence of distant metastasis. Once a diagnosis of osteogenic sarcoma has been definitely made, then there should be no



waste of time either on the part of the patient or the surgeon. The generally accepted procedure of choice is amputation above the proximal joint of the bone affected. In the case of upper extremity, interscapulo—thoracic amputation is the only procedure when tumours involve the upper end of humerus. We have had 24 cases of osteogenic sarcomas. Of the 24 osteogenic sarcomas, 12 involved the lower end of the femur, 5 upper end of humerus, 2 upper end of fibula, 3 upper end of the tibia, one clavicle and radius. Of the 24 cases, only 13 received treatment. Amputation was performed in 6, disarticulation at hip in 3, and interscapulo—thoracic amputation in 4. Of the 13 treated cases, one died at the hospital 14 months after treatment. Two have remained well after treatment for one and two years respectively. Another case remained well and free of disease for 18 months after treatment when he developed generalised metastasis and expired. A British soldier on whom we performed an interscapulo—thoracic amputation was invalided to England and was lost to follow up. We had one case of osteogenic sarcoma superimposed on Paget's disease of bones and expired at his native place 6 months after amputation. Three were followed for periods of 6 to 9 months after treatment. The remaining have been lost to the follow up department and are presumably dead. As an example, I will describe a case of osteogenic sarcoma of the upper end of humerus with axillary lymph metastasis. A 24 year old British soldier (Case No. 3120) was admitted to the hospital on 29-9-42 with the history that whilst lifting a heavy weight, he felt a sudden pain on top of his left shoulder. Six months later a painful swelling appeared. On examination, he had a fusiform enlargement of the left shoulder. X-ray studies revealed osteogenic sarcoma involving the upper end of left humerus. Alkaline phosphatase level was 11.4 Bodansky Units. Interscapulo — thoracic amputation was performed together with the removal of axillary areolar tissue. Microscopic report on the specimen

removed was osteogenic sarcoma with infiltration of marrow cavity, the deltoid muscle and metastasis to two axillary lymph nodes. Alkaline phosphatase after the operation had fallen to 3.6 Bodansky Units. He received post-operative irradiation, and was later invalided to England.

In case of *Multiple Myeloma*, X-ray therapy is the treatment of choice. These tumours are radiosensitive, but the outcome of the patient is quite hopeless. In recent years, Stilbamidine and Pentamidine (Diamidine compounds not containing antimony) combined with a diet low in animal protein are used in the treatment of multiple myeloma for the relief of pain. The disease is not cured by these drugs, but is temporarily checked in its further development. We have no experience with these drugs in these cases.

We have had four cases of multiple myeloma, all microscopically proved by aspiration biopsy. All have died. One lived for 10 months after treatment, one for 7 months after treatment, one for 6 months and the 4th one for three months after treatment. They were all treated by X-ray therapy. A 53 year old Parsi female (Case No. 5282) was admitted on 17-9-43 with the history of pain and swelling over the right shoulder of six months duration. Pain appeared first, and two months later the swelling. There was a rounded swelling involving the scapula, and a clinical diagnosis of a possible giant cell tumour was made. Radiographic interpretation was osteolytic osteogenic sarcoma. Aspiration biopsy was reported as plasma cell myeloma. X-ray studies of the skull and other bones revealed no abnormality and so the case was thought to be a solitary myeloma. Bence-Jones Bodies were present in the urine. Blood chemistry revealed hyperproteinaemia and the albumin globulin ratio was one to one. Patient was treated with X-ray therapy (1800 r) with complete disappearance of pain and tumour. Three months after the completion of X-ray treatment, she developed pain in the lower back, and also small masses on the vertex of the skull. X-ray studies

revealed similar lesions as the previous one. She was treated with X-ray with marked relief of pain. She later developed similar lesions in the ribs and a pathological fracture involving the upper end of left humerus. She ultimately expired on 7-6-44, nine months after the date of first application.

With regard to the other malignant tumours, Reticulum Cell Sarcoma of the bone is a relatively infrequent tumour. It is radiosensitive and can be treated with deep X-ray therapy. We have had four cases of Reticulum Cell Sarcoma. One case of ours is alive for the last four years, although crippled. We had two cases of lipogenic sarcoma, and one was treated with X-ray therapy and was followed for six months after treatment.

### PROGNOSIS

Of all the bone tumours, giant cell tumours have the best prognosis. A large number of permanent control of these tumours following irradiation have been reported in the literature. Surgery in the nature of curettage, cauterization and primary wound closure is said to be followed by recurrence in 25% of the cases, but those who advocate this procedure maintain, that if this procedure is carefully carried out, it also gives rise to a large number of permanent cures. Ewing's tumour has a poor prognosis. Of 114 cases seen at the Mayo Clinic as cited by Ackerman and Regato, 21 lived five or more years. Of these, 8 had amputations, two had wide excisions and eleven were treated by radiation (Meyerding). The Registry of Bone Sarcoma as cited by Ackerman and Regato reported on 55 cases which were followed for 5 years or more, and there were 15 five-year survivals. Geschickter reported 135 cases with only 6% five-year survivals. The prognosis of osteogenic sarcoma depends upon many factors e.g. age. Patients between the ages of 20 and 40 years seem to

have the most favourable prospect of five-year survival, whereas patients under 20 and over 50 have the least favourable outlook. Osteogenic Sarcoma occurring in a case of Paget's disease gives rise to a very poor prognosis. Location of the tumour is also important from the prognostic point of view. When these tumours occur in areas where they cannot be surgically removed, e.g. vertebra, skull, pelvis, the prognosis seems hopeless. According to Coley and Pool, the more peripheral the tumour, the more favourable the prognosis. Conversely the more nearer the tumour to the trunk, the worse the prognosis. The microscopic grading of the tumour is also of great importance in regard to the prognosis (Uniformity or pleomorphism of cell type).

Coley and Pool have divided their cases into tumours of low, average and high grade malignancy. They have shown that of 36 cases with tumours of low grade malignancy, 40% survived five years, of 98 with tumours of average grade malignancy, 16% survived five years, and of 26 with high grade malignancy 15% survived five years. The type of treatment employed also influences the prognosis. Amputation alone or with preoperative radiation has given 32% five year survivals in the series reported by Coley and Pool. Radiation alone was used in 35 cases with 3 survivals or 9%. They have reported 35 five-year survivals out of a total of 160 histologically proved cases, thus giving them a five-year survival rate of 22%. A case of multiple myeloma has the most fatal prognosis. The average life expectancy ranges around 14 months.

I have endeavoured in the short time available to cover the subject of Bone Tumours, touching only on some of the important problems that we have met with in our experience. I am sure that there are various other problems that have received scant notice in this paper and I trust that they will be brought out in the discussion that will follow.

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# OBSERVATIONS ON OSTEOGENIC SARCOMA AND OSTEOCLASTOMA

by M. G. KINI.

## TUMOURS OF BONE

*"Do not fear to defend new ideas even the most revolutionary. Your own faith is what counts most. But have courage also to admit an error as soon as you have proved yourself that your idea is wrong. Science is the graveyard of ideas but some ideas that seem dead and buried may at one time or another rise up to life again more vital than ever."*

—LOUIS PASTEUR.

Tumours of the skeletal bones are varied and the pathology of these tumours is being put on a rational basis. Benign tumours of the type of Osteomas are excluded from the purview of this paper. Osteogenic sarcomas and giant cell tumours are included in the scope of this paper.

The work of Kolodny, Codman, Copeland and Geschickter, Ewing, Plattjaffe, Macdonald and Budd and the American Registry of Bone Sarcomas have helped to have a clearer view of the bone tumours in general and sarcomas and benign giant cell tumours in particular. This classification has given us a fair indication of the way in which we can approach this subject.

Recorded evidence in India is meagre in this respect. The object of this paper is to focus the attention of the surgeons with regard to incidence, causation, pathology, treatment and follow up results. An attempt was made to keep a record of the incidence of the bone tumours seen in the outpatients and inpatients. 100 cases were recorded from 1932 to 1941. Unfortunately, the register in which these were recorded in the advanced stage of the disease and who were not considered suitable for admission were seen as outpatients only, to prevent overcrowding in the hospital, and the record of these cases has been lost. The following 49 cases of osteogenic sarcoma and 17 cases of benign cell tumours of which there is complete recorded evidence,

shows that this type of disease is not less common in India.

## OSTEOGENIC SARCOMA

Bone sarcomas usually occur among the younger people. The appended statement gives the details of incidence, pathological details consisting of biopsy-reports, histological findings after amputation and post-mortem findings with photographic evidence consisting of clinical photographs and radiological pictures of 49 cases of sarcomas and 17 cases of osteoclastomas or benign giant cell tumours.

The average duration of the disease in respect of the above 49 cases when they sought admission was 6 months and 23 days. The shortest duration was 23 days, the longest being 2 years. 32 were males and 16 females and one was a male child. It is possible that we cannot place much reliance on the history given by the patients as they were all illiterate and the assessment of the duration of trouble given by them must have been from the time when the disease became very appreciable to the naked eye and became more painful.

The following statement gives at a glance the site of the tumour, i.e. the commonest sites where these tumours are usually occurring, sex, side, average age of the individuals and easy reference to age for quick comparison with the detailed statement of cases. The numerators in the age reference column indicate the serial number

Site.	Sex		Side		Total	Age			Age reference to statement		
	M.	F.	Rt.	Lt.		Average	Youngest	Oldest			
Femur	...	11	5	...	6	10	16	22.2	7	60	3-60, 7-20, 10-16, 16-16, 17-22, 18-30, 20-25, 24-25, 31-7, 38-20, 40-21, 41-21, 42-15, 43-21, 46-18, 49-17.
Tibia	...	5	6	...	4	7	11	23.1	15	30	1-20, 2-25, 8-16, 11-25, 12-15, 14-20, 15-20, 21-28, 22-30, 36-30, 47-25.
Humerus	...	5	2	..	3	4	7	21.0	14	32	4-18, 17-20, 23-14, 33-20, 34-25, 39-18, 45-32.
Ileum	..	4	...	...	2	2	4	28.8	15	56	5-25, 23-23, 32-56, 35-50.
Scapula	...	3	...	...	2	1	3	23.3	18	30	16-18, 37-23, 44-30.
Skull bone	...	1	..	..	1	...	1	25.0	...	...	13-25.
Maxilla	...	...	1	...	1	...	1	25.0	...	...	29-25.
Radius	..	...	1	..	..	1	1	25.0	...	...	26-25.
Ulna	..	1	...	...	1	...	1	25.0	...	...	25-25.
Metacarpal	...	1	...	...	1	...	1	30.0	..	...	30-30
Phalanges	...	..	1	...	1	...	1	30.0	...	...	48-30.
Fibula	...	...	1	...	1	1	1	40.0	...	...	19-40.
Metatarsal	...	1	...	...	1	1	1	50.0	...	...	9-50.
Total	...	32	17		24	27	49				

of the cases in the detailed statement and the denominators the age of the case.

44 out of the above 49 cases have photographic evidence, majority of them have both clinical as well as x-ray photographs. Of the five remaining cases, x-rays have been lost. All the 17 cases of osteoclastoma have got either clinical photographs or both clinical and radiological photographs or radiological picture only.

In the case of the osteogenic sarcomas, the history of an injury as a precursor of the disease is not borne out by the recorded evidence.

The causation of sarcoma is not clearly understood. The experimental study of Peyton Rous with regard to the fowl and rabbit sarcoma shows that virus infection plays a part in the production of sarcoma. The work of the Russian microbiologist Nikolai Gamalai shows that malignant tumour is the result of virus infection which by penetrating into the cell causes intensive multiplications on the

analogy of Infusoria who free themselves of bacteria which have penetrated into their nuclei by intensive multiplication of cells in seeking to eject the virus into the protoplasm. Prof. Levi Zilber believed that the virus having caused transformation of animal cell into tumour cell perishes or separates itself from the tumour cell as the modified cell has become uncomfortable for its existence and therefore it is difficult to demonstrate the virus in the adult tumour cells. Therefore it is presumed that the tumour virus differs from the other viruses of infectious diseases.

Bone reacts to infection in somewhat similar way as is seen in sarcoma and having a rich reticulo-endothelial system it is quite possible that the bone in its effort to shake off its virus infection may turn malignant, and lead to the development of bone sarcoma. It would be a fruitful source of research to elucidate the cause of sarcomas bearing this in mind. Most of the cases of sarcomas seek advice for pain from

the very start, particularly marked at night causing sleeplessness. As a matter of fact, pain of infection and sarcoma are almost identical with this exception that the constitutional reaction early in the disease is greater in osteomyelitis than in sarcoma and the constitutional changes in sarcoma occur later in the disease.

In presenting this paper, it is premised that no special work with regard to this has been done though the material was ample and co-ordinated work could not be carried out due to imperfect organisation and equipment. The average practitioner and general surgeon in India, less conversant with bone sarcomas and having no post-graduate education does not diagnose this disease and sometimes makes mistakes by wrongly diagnosing these as cases of osteomyelitis and incise the tumour. Sometimes, indigenous practitioners who are considered tumour specialists apply irritant drugs hoping to dissolve the tumour, and exacerbate the disease after the first or the second application. Sometimes these tumour areas are cauterised by the usual country thermo cautery, as a counter irritant for the intense pain and after this procedure, the tumour takes on a more malignant course with rapid dissemination. The dissemination of this disease is usually in the lungs but the following cases are of interest as the dissemination occurred in other parts of the skeleton mostly on the same side as the original growth.

Case No. 1—this was incised mistaking it for an abscess and the dissemination was presumed to have occurred in the left humerus because she suffered from intense pain exactly two months after the incision and died 5 months after.

Case No. 5—is an illustration of the dissemination of the disease from the right iliac bone to the right humerus and right temple.

Case No. 6—after excision of rt. scapula, recurrence occurred locally and dissemination occurred in the right iliac bone.

Case No. 37—was given electrical massage and incised and secondaries occurred in the lung.

It is not clear as to why dissemination should occur on the same side of the skeleton and not in other parts of the skeleton as the dissemination is by the blood stream.

Cases Nos. 8, 17 and 42 were suggestive of Ewing's sarcoma.

Case No. 8 was cytologically suggestive of Ewing's sarcoma but the radio-therapeutic test was negative.

Case No. 17—was suggestive of Ewing's sarcoma radiologically, but the therapeutic test by x-ray could not be done and the biopsy report was suggestive.

Case No. 42—was suggestive histologically but the radio-therapeutic test was negative.

Case Nos. 5, 6 and 9—died in the hospital and complete post mortems were done.

There were four cases of Chondrosarcoma—one in the meta-carpal of the hand, one in the metatarsal of the foot and one in the upper end of the tibia and one in the phalanx of the hand. Cases No. 30, 9, 14 and 48.

Case No. 9—died suddenly on the day posted for an amputation. He had developed gangrene. A post mortem was done. Nos. 14 and 30 were amputated—see Figs. 12, 17, 17-a, 32 and 32-a.

The difficulty in diagnosis becomes obvious only when we make a follow up study. The following atypical cases are of interest.

Case No. I—a woman who was admitted for tumour of the lower end of the femur in the wards, aged 35 years, was diagnosed from radiological appearance as a case of sarcoma of femur and she was advised amputation which she promptly refused and obtained her discharge from the hospital. On follow up after three years, she stated that she was keeping very fit. Though she was asked to come for re-investigation, she pleaded poverty to come and report. It was presumed that it was a case of syphilitic infection of the bone, as

no case of sarcoma could have lived after three years without any treatment. Fig. 1 & 1-a.

Case No. II—a case of ulcerating growth of the wrist with thickening of the bone was admitted as a case of ulcerating sarcoma of bone. Radiological picture is not available as it has been lost. After a therapeutic test, the healing was complete. Fig. 2 & 2-a.

Case No. III—a girl aged 16 years admitted for swelling in the thenar eminence which resembled a tumour with ulceration and foul smelling discharge. The ulcers on the radial border were typically gummatous. This is illustrated to show that a careful assessment of ulceration is essential in differential diagnosis. Antisyphilitic treatment with removal of the metacarpal of the thumb which was secondarily infected and sequestered cured this condition. Fig. 3 & 3-a.

Case No. IV—a Hindu, male, aged 35 years, was admitted for a tumour in the lower end of the femur. On clinical examination, it appeared like a case of sarcoma and the radiological picture showed it to be a sclerosing type of sarcoma. On therapeutic test, it proved to be a case of specific osteo-periostitis. Fig. 4.

Case No. V—Hindu, male, aged 40 years, admitted for swelling in the medial aspect of the thigh with intense pain was diagnosed to be a case of sarcoma. Radiological picture shows erosion below lesser trochanter with parallel thickening of cortex on medial aspect below. On therapeutic test, it was proved to be due to syphilitic infection of bone. Fig. 5.

Case No. VI—(not illustrated) was a young Indian Christian, aged 25 years, consulted a surgeon of repute for a swelling in the upper end of the right leg. Radiological examination showed expansion of the upper end of the fibula with lamination and rarefaction suggestive of a Ewing's sarcoma. He was advised amputation by the surgeon who saw him. Subsequently, a second medical opinion decided on giving a therapeutic test for syphilis which proved to be negative. Later he was sent for a course of irradiation by deep x-ray by an expert radiologist. Biopsy was not done. The

tumour showed signs of re-calcification and differentiation of the cortex and medulla. He went home and subjected himself to indigenous treatment and now after 7 years he is alive. This individual is rather an extraordinary man and he would not come back or get himself re-x-rayed in spite of persuasion and he believes that the cure was due to indigenous medicine. It is not possible to illustrate this case as all the x-rays are in the possession of the patient and he is refusing to give them even for taking prints.

The only reason for presenting this paper is that every case of tumour of bone that comes to the hospital for treatment should have an organised and clear cut method of approach in the diagnosis and treatment.

1. A clear history of the case should be taken. This is one of the things lacking in most of the clinical institutions in India.

2. A study of the blood such as blood picture, Wasserman reaction, biochemical examination for blood calcium, blood phosphatase, etc. etc.

3. A good radiological picture efficiently taken and studied correlating it if possible with pathological findings.

4. A therapeutic test not depending upon the Wasserman or Kahn tests. It is always found that if the pathology is due to syphilis after the administration of three injections of arsenical preparations, the pain begins to subside and the patient begins to show improvement. Syphilis can mimic any type of tumour inclusive of sarcomas of bone—cf. Figs. 1, 1-a, 2, 2-a, 3, 3-a, 4 and 5.

Case No. 16 is a case which illustrates that though the Wasserman was strong positive, radiologically it was difficult to assess the pathological condition. Treatment by antisyphilitic drugs had no effect. Later radium implantation was done and the condition improved and she lived for 2 years. She gave birth to a child and died 6 months afterwards of the same disease. It is presumed that it was a case of Ewing's tumour from the radiological picture and reaction to radium and follow up. X-ray therapy may help to differentiate sarcomas from

Ewing's tumour which is very radio-sensitive.

It has not been possible in the earlier part of the investigations to correlate the x-ray therapeutic test for differentiating osteogenic sarcomas from Ewing's tumour. Interstitial radiation was tried in a few cases instead, with doubtful results.

5. Treatment by deep x-rays is useful and facilities should be provided. In the earlier part of the study of the problem no facilities for this method of treatment were existing and in recent times it has been advocated to give a tumour dose of deep x-rays before amputation. Such treatment has prolonged the life of the amputees.

6. A biopsy study wherever possible. This should be undertaken in the case of sarcomas when therapeutic tests are negative and before sacrificing the limb. After the application of a firm tourniquet above the site of the tumour, aspiration, suction or Turkel trephine biopsy should be done from the tumour below the tourniquet. There should be facilities for immediate biopsy report by studying frozen sections. Development of a team is essential to avoid pitfalls.

In this connection it would be interesting to recall the experience of Stephen Paget in the St. Bartholomew's hospital, London. In this hospital it was the practice that general consultations should be held as a routine before a limb was sacrificed. One case was pronounced after due consideration by all surgeons to be a case of sarcoma and amputation was advised and done. Eventually after amputation, on section it was found to be a case of chronic osteomyelitis with a small sequestrum in the centre of the swelling surrounded by a lot of thick new bone formation. This is now commonly known in literature as "quiet necrosis of Paget" and the specimen has been preserved.

7. Amputation of limb may be undertaken. Chondro-sarcomas were amenable to this type of treatment. Cases Nos. 14, 30 and 48.

It has not been possible to demonstrate the dissemination of the disease by means of radiograms after amputation, before they were discharged from the hospital.

Those cases that had shown dissemination have died. The published literature states that even after amputation, no cure can be guaranteed.

In this connection I wish to draw the attention of all surgeons to the difficulties of advising this procedure. Case shown in Fig. 1 is an illustration. This advice was given by my assistant in 1933 when I was on leave and this case was filed with x-ray reduction picture in the sarcoma file. A follow up was attempted in 1940 and the reply was astonishing. A careful study of her notes and x-rays was made. Her blood Wasserman test was + + +. A therapeutic test would have settled the question.

Amputation of limbs can also be undertaken in advanced cases to prevent loss of blood and save the patients from foul smell from the fungating tumours after inadvertent incisions that were made mistaking the tumour for an abscess. Case No. 1 had a foul smelling growth after incision and had secondaries. In spite of this amputation was done.

In case No. 49, even though there were secondaries in the lungs, the case was amputated as he had intractable pain.

8. Last of all it is essential to impress on the Government the necessity to have a register for malignant diseases in general and tumours of bones in particular. The prognosis of cancer has altered since the advent of x-ray and radium but in the case of sarcomas it is disappointing. The following analysis shows that the tale of sarcoma is a tale of woe and no case which has been conclusively proved to be a case of sarcoma has lived over a period of time. An attempt at follow up was made of all cases to find out,

(i) the duration of life after a firm diagnosis of sarcoma was made with the help of special investigations, and,



(ii) whether the diagnosis made was correct.

In most cases follow up was not successful. In successful cases results were disappointing.

The following is an analysis of cases where treatment was advised and adopted :—

- A. Advanced inoperable cases and unsuited for any type of treatment—Nos. 23, 27, 28, 32, 33, 34, 35, 37, 39.
- B. Treated by deep x-ray—Nos. 8, 42 (No. 8 died at home).
- C. Treated by excision with recurrence—No. 6 (died in hospital, post mortem done).
- D. Those that had secondaries already and unfit for treatment—Nos. 1, 3,

5, 40 & 49 (3 and 5 died in Hospital. Post mortems done).

- E. Treated by interstitial radiation—Nos. 2, 13, 16, 19 (16 died at home, 2 years later and six months after giving birth to a child).
- F. Treatment by excision or amputation of cases which consented to this line of treatment—Nos. 9, 14, 29, 30 (9 died suddenly on the day fixed for operation. Post mortem done).
- G. Treated by amputation of cases which consented to this procedure to save them from the bad smell due to bleeding or severe pain—Nos. 1 and 49 (shown under item D).
- H. Discharged otherwise—Nos. 4, 7, 10, 11, 12, 15, 17, 18, 20, 21, 22, 24, 25, 26, 31, 36, 38, 41, 43, 44, 45, 46, 47, 48.



Fig 1

Clinical photo of the lower end of the femur in the region of the knee mistaken for sarcoma and the patient was advised amputation.

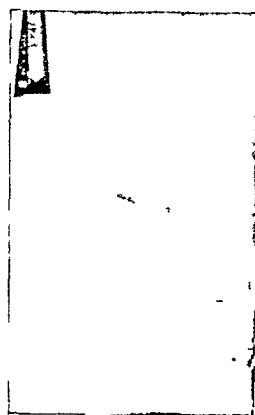


Fig. 1-a.

Shows evidence of periosteal reaction with dense deposit of bone with decalcification in the centre resembling a sarcoma—on follow up with indigenous treatment she was found to be alive and is presumed to be syphilitic.

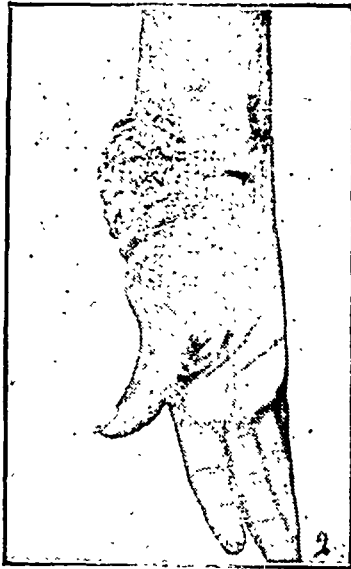


Fig. 2.

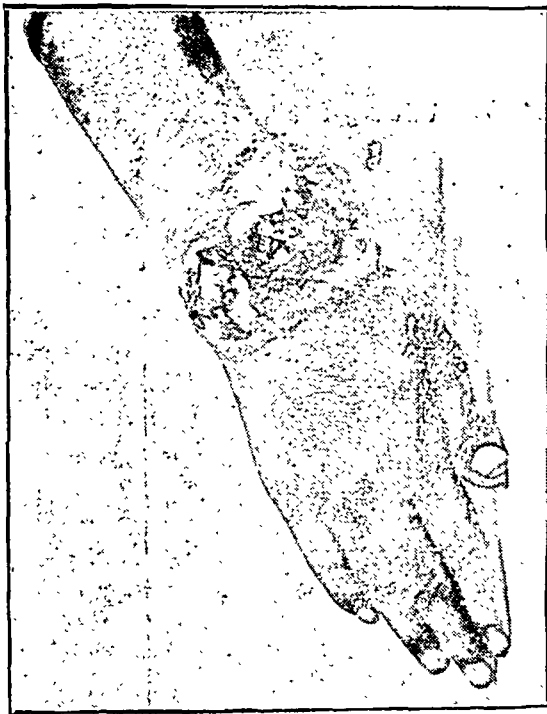


Fig. 2-a.

Clinical photographs of the wrist showing ulceration with thickening of the lower end of radius mistaken for ulcerating growth of lower end of the radius. This was proved to be due to syphilis after therapeutic test.

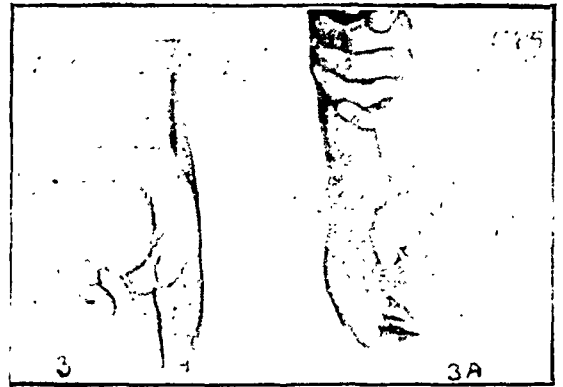


Fig. 3 & 3-a.

Clinical photographs showing the swelling in the region of the thenar eminence—may be mistaken for Chondroma but the dorsal view showed ulceration characteristic of syphilis.

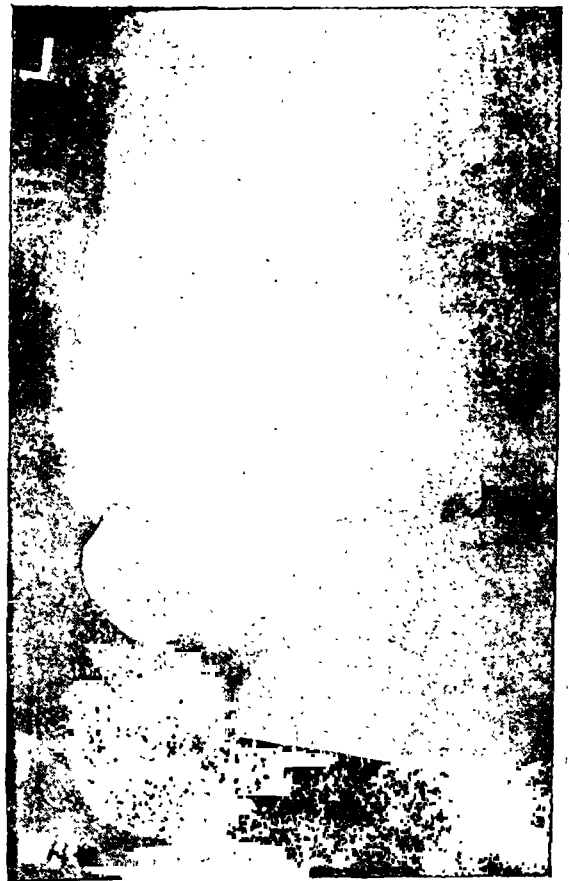


Fig. 4.

Radiogram of the lower end of the femur easily mistaken for sarcoma with dense osteoperiosteal reaction with formation of new bone. This was proved to be due to syphilis after therapeutic test.

Fig. 5.

Shows a growth on the medial aspect of the upper end of the thigh—shows rarefaction below the lesser trochanter and new bone formation parallel with the shaft of the bone easily mistaken for sarcoma—this was proved to be due to syphilis.



Fig. 6.

Clinical photograph of sarcoma of tibia—note fungation result of incision thinking it to be an abscess.



Fig. 7.

Clinical photo showing the tumour in the region of the right knee.

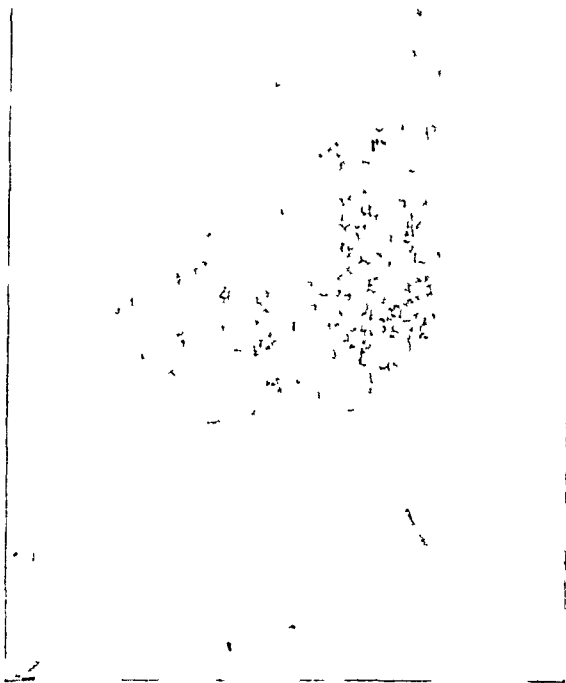


Fig. 7-a.

Radiograph showing a diffused growth with spicules of bone extending into the growth—the cortex and medulla are not easily seen in the photo having been masked by the growth.

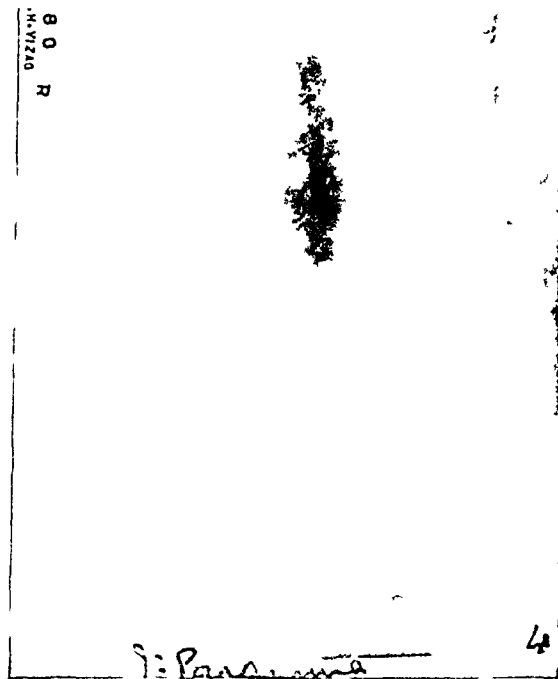


Fig. 8.

X-ray picture of the upper end of the humerus —note the diffused growth extending from the upper end to the junction of the middle and lower third of the humerus—note the rarefaction of the bone shaft in the middle of the growth with new bone formation giving sun-ray appearance.

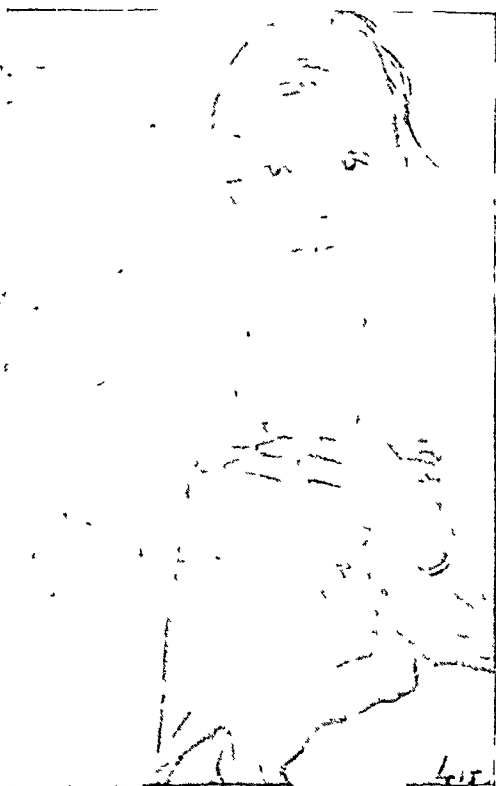


Fig 8-a.

Clinical photo of the same case.

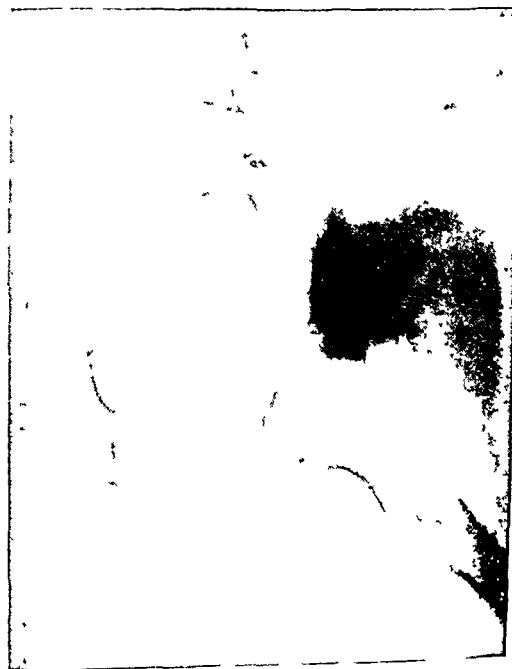


Fig. 9.

Radiogram showing the diffuse thickening of the ilium extending from the upper margin of the acetabulum on the left side

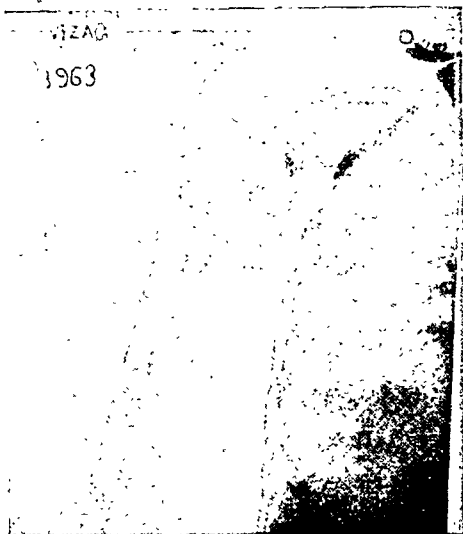


Fig. 9-a.

X-ray of the upper end of the left shoulder (but reversed during printing) showing the periosteal beaking of Codman.



Fig. 9-b.

A pathological specimen removed showing the growth in the skull from within.



Fig. 10.

Shows the back view of the growth from the right scapula.



Fig. 10-a.

Shows the x-ray which is not quite clear—shows the tumour is mottled with the bony structure.



Fig. 10-b.  
The case after operation (excision).



Fig. 10-c.  
Recurrence of the growth after 6 months (back view)



Fig. 10-d.  
Recurrence of the growth after 6 months (front view).

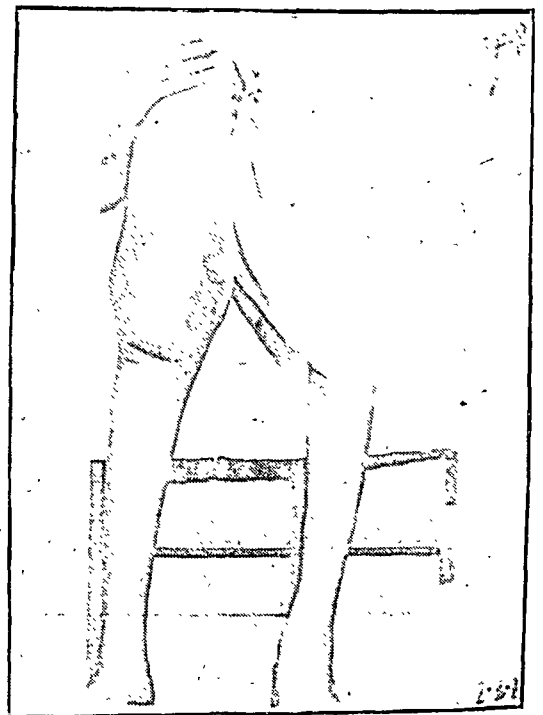


Fig. 11.  
Clinical photograph of the growth in the lower end of the femur.



Fig. 11-a.

Photograph showing the growth in the lower end of the metaphysis and diaphysis of the femur—shows sun-ray appearance and spicules with evidence of beaking in the upper part as described by Codman.



Fig. 12.

Is a clinical photograph showing the side of the growth which had broken down in places.

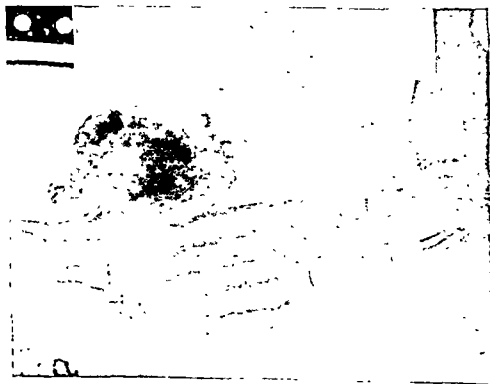


Fig. 12-a.

Radiogram showing lateral view of the growth—note superimposed patchy calcification in the region of the 1st metatarsal.



Fig. 13.

Is a clinical photograph showing the shape and side of growth in the thigh.



Fig. 13-a.

Radiogram showing the growth with sun-ray appearances arising from the periosteum.

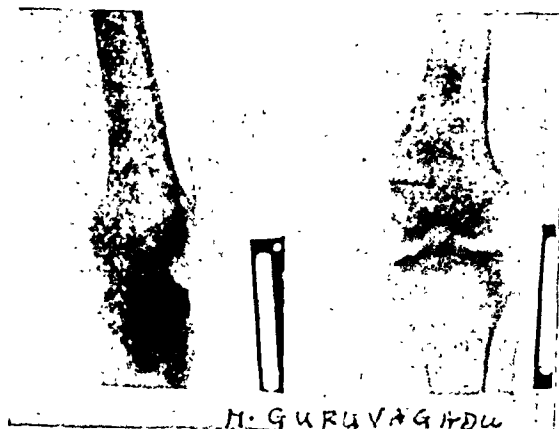


Fig. 14.

Radiogram showing the upper end of the tibia being replaced by a growth which shows intense decalcification—very little bony reaction.



Fig. 15.

Is a clinical photograph showing the lateral view—note the oedema of the leg and foot.



Fig. 15-a.

Is an anterior view showing the breaking down after an incision made mistaking it for an abscess.





Fig. 16.

Is a clinical photograph showing the lateral view of the growth arising from right temple.



Fig. 16-a.

Anterior view of the growth from the right temple.



Fig. 16-b.

Showing recession of the growth after radiation.



Fig. 16-c.

Lateral view showing the recession of the growth after radiation.

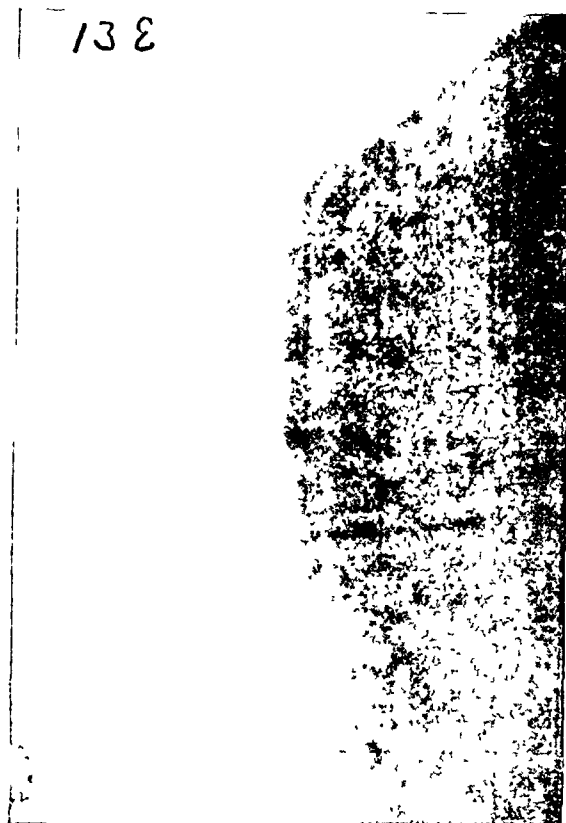


Fig. 16-d & 16-e.

Radiograms showing some periosteal reaction from the temporal aspect of the bone.

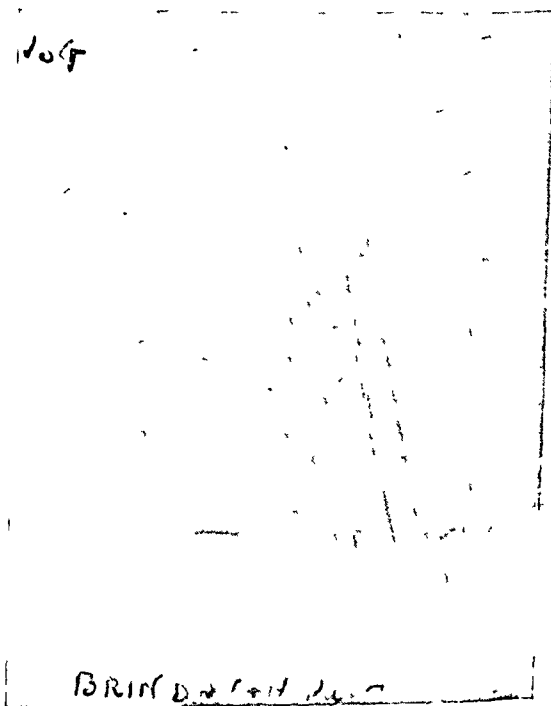
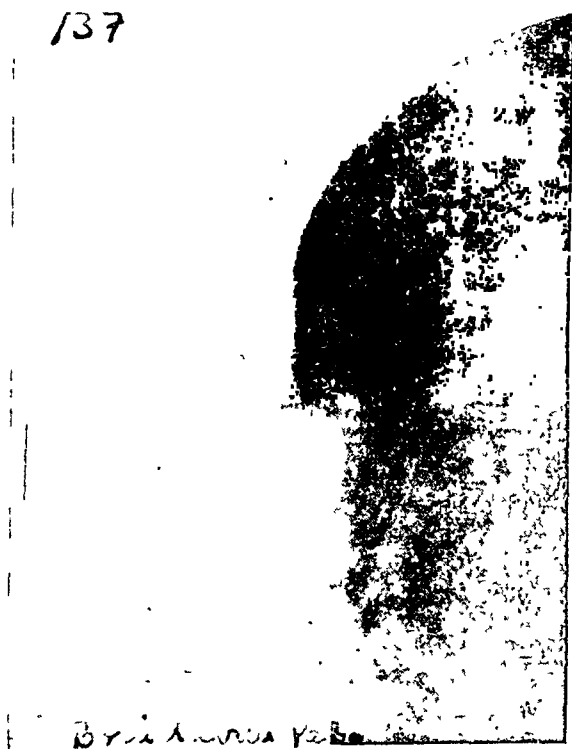


Fig. 16-f & 16-g.

Radiograms showing result after radiation.

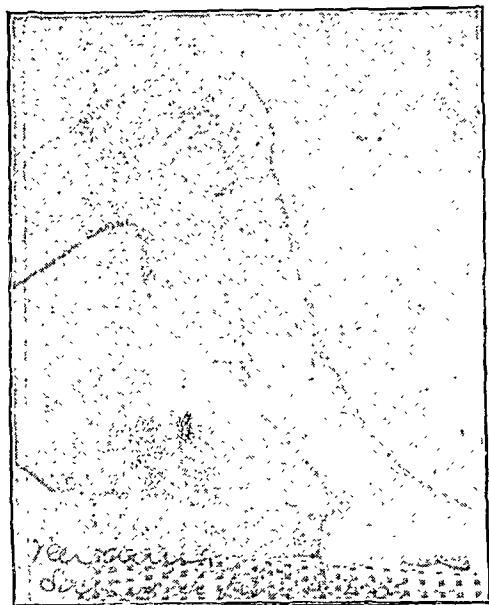


Fig. 17.

Shows the recurrence of the growth at the site of incision made in the upper end of tibia.

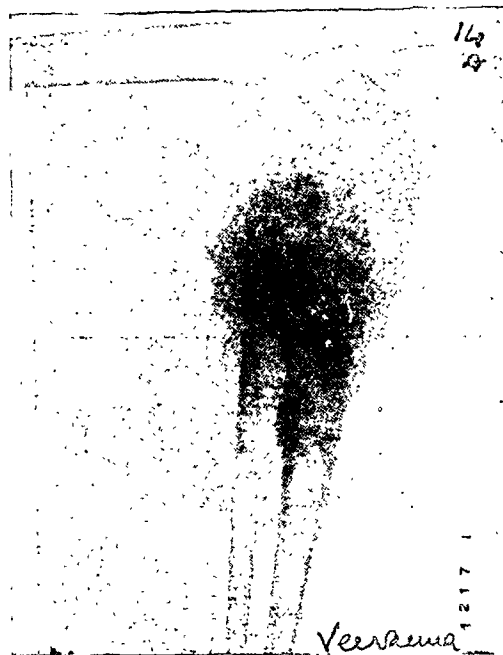


Fig. 17-a.

Radiogram shows dense ossification in the upper end of the tibia with dense periosteal reaction.



Fig. 18.

Radiogram showing destruction of the upper end of tibia with decalcification extending into the diaphysis of the tibia beyond the growth.



Fig. 18-a.

Clinical photograph—note the scars, result of thermal burns used for pain due to this tumour.

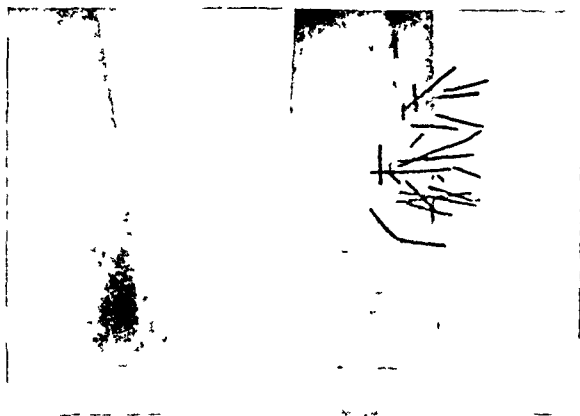


Fig. 19.

Radiograms showing the periosteal reaction with density in the medullary part of it and radium needles in situ.

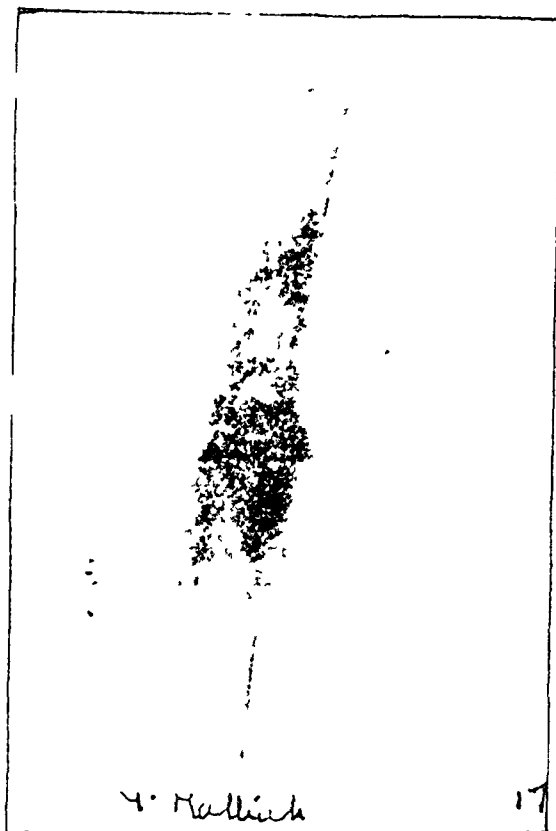


Fig. 20.

Shows a growth in the middle of the shaft of the femur with peculiar bony reaction at right angles to the shaft but with marked density in the compact and the medullary aspect of it.

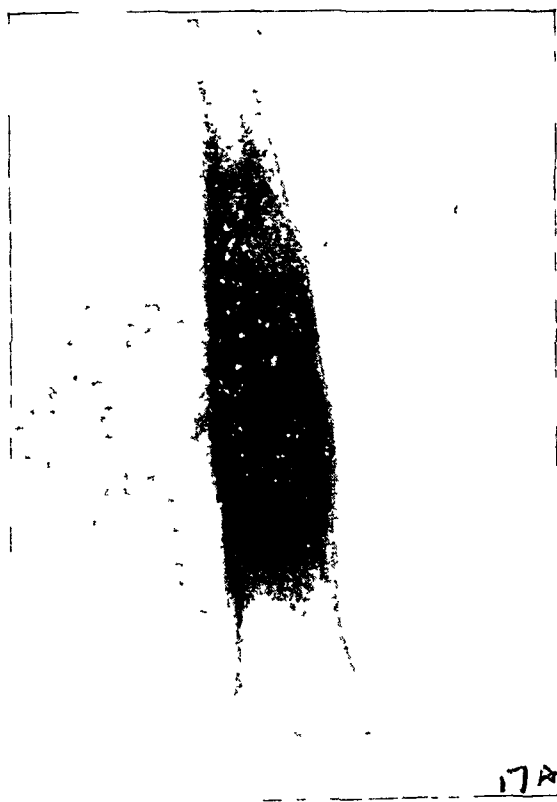


Fig. 20-a.

A. P. view of the same.



Fig. 20-b.

Clinical photo of the same.

KGHXRAY

19

Nooko.lanning 30

Fig 21.

Shows a growth arising from the upper end of the fibula, rarefaction of the posterior aspect of the tibia in the compact area.

KGHXRAY  
VIZAG R.2250

Fig 21-a

Lateral view of the same.

KGHXRAY

R 241

KGHXRAY  
VIZAG

Fig. 21-b & 21-c.

Radium embedded in the growth.

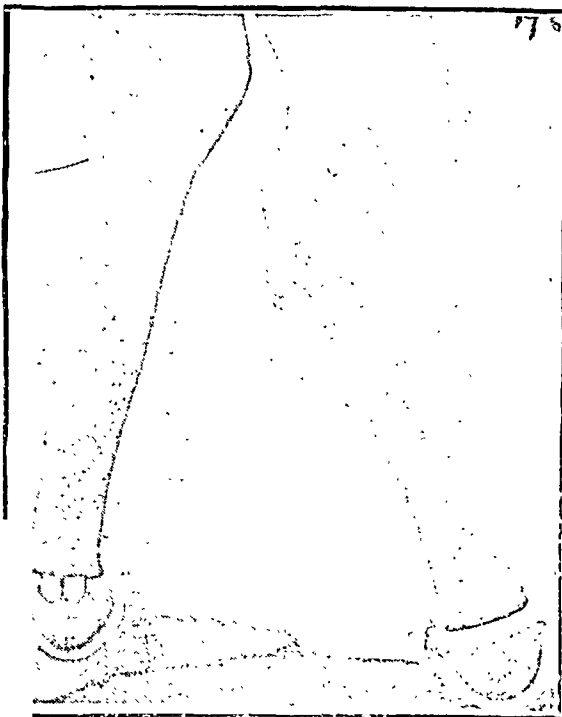


Fig. 21-d.  
Clinical photograph of the same.

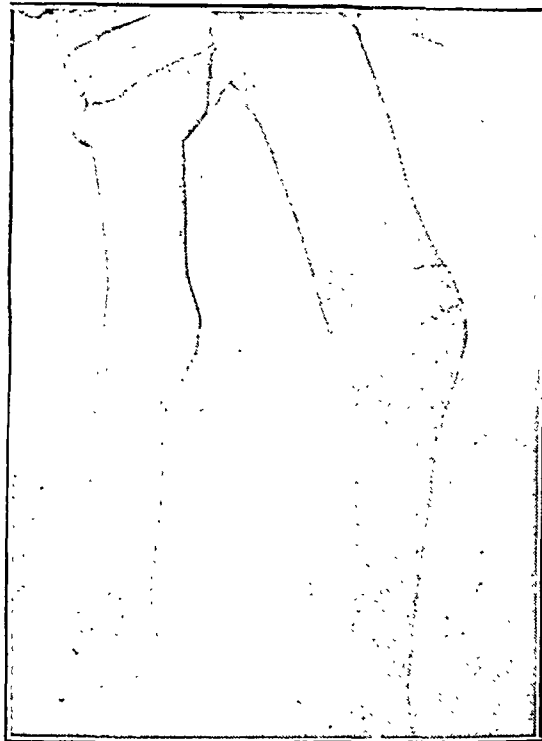


Fig. 22.  
Is a clinical photograph showing the lateral view of the growth in the lower end of the femur with linear scars over the skin result of country thermal cautery used for relieving pain due to the disease.

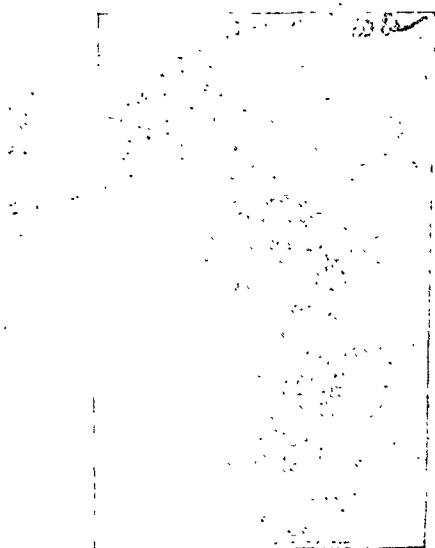


Fig. 22-a.  
Radiogram—lateral view showing dense periosteal reaction with erosion of the trigone.



Fig. 23.  
Clinical photo showing growth in the upper end of the tibia.



Fig. 23-a

Radiogram showing the rarefaction in the upper end of the tibia.

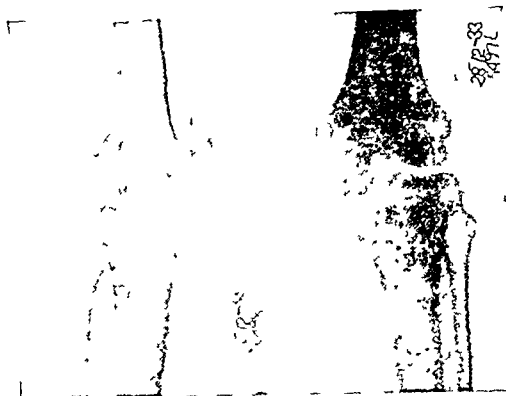


Fig. 24.

A.P. and lateral views showing changes in the upper end of tibia with periosteal reaction.



Fig 25

Shows the growth in the ala of the ilium—note the mottled appearance.



Fig. 26.

Is a clinical photograph showing a big sized growth of the lower end of the femur with fungation at one place with evidence of circular scars result of country thermo cautery.

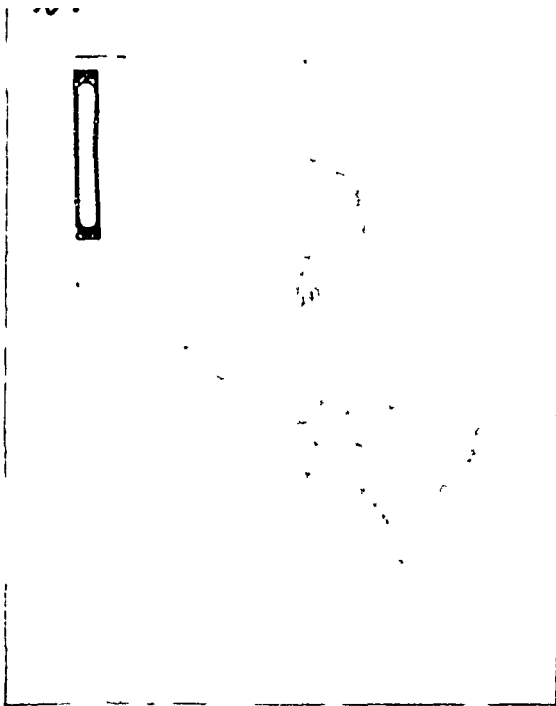


Fig 26-a.

A.P. view showing destruction in the lower end of the femur with patchy calcification—note the changes in the diaphysis with decalcification beyond the growth.

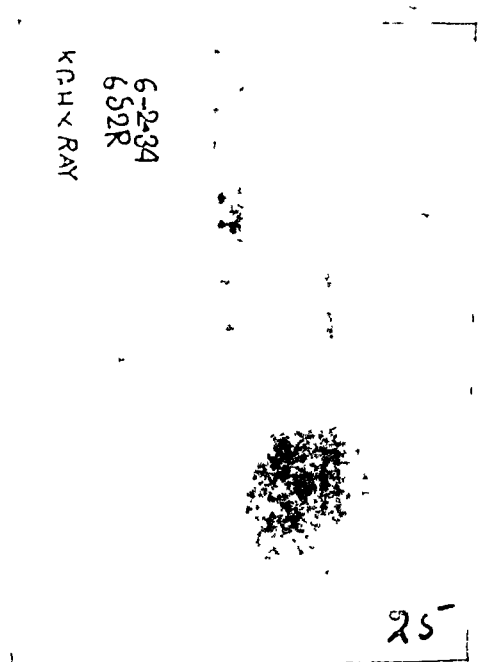


Fig. 27.

Radiogram, lateral view showing calcification in a big growth arising from the ulna (? a case of calcification in a parosteal fibro-sarcoma).

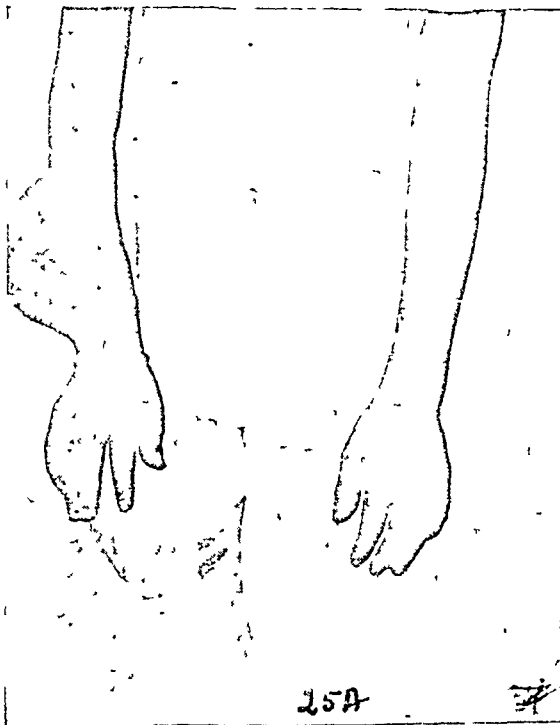


Fig. 27-a.

Is a clinical photograph showing the growth.

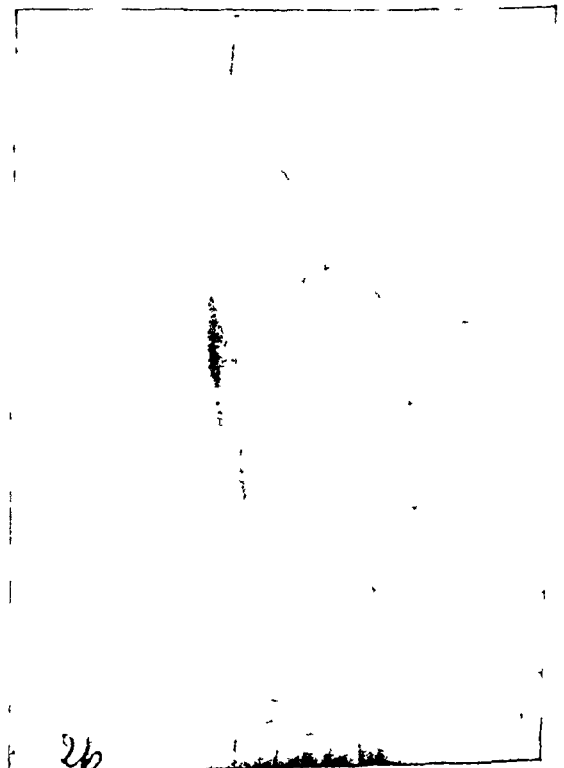


Fig. 28.

Radiogram showing an enormous growth arising from the radius—note the irregular patchy calcification.





Fig. 29.

Clinical photo showing the growth in the upper end of the humerus.



Fig. 29-a.

Radiogram showing deposits in the lungs.

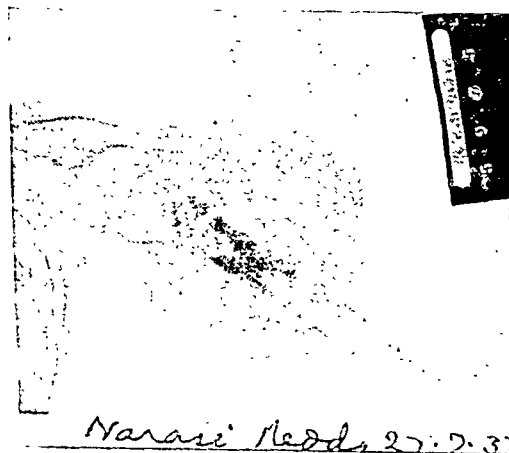


Fig. 29-b.

Radiogram showing the destruction of the upper end with periosteal reaction—note the beaking.



Fig. 30.

Shows a scar which might have been an old operation scar with ulceration in an enormous growth in the upper end of the humerus.

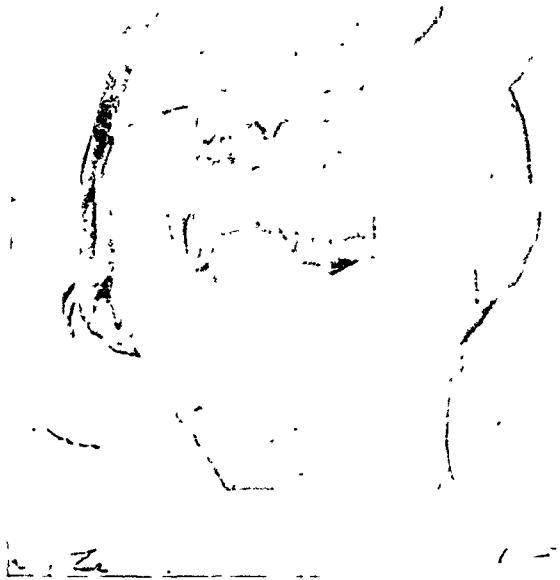


Fig. 31.

Shows the growth in relief after eversion of the upper lip on the left side.

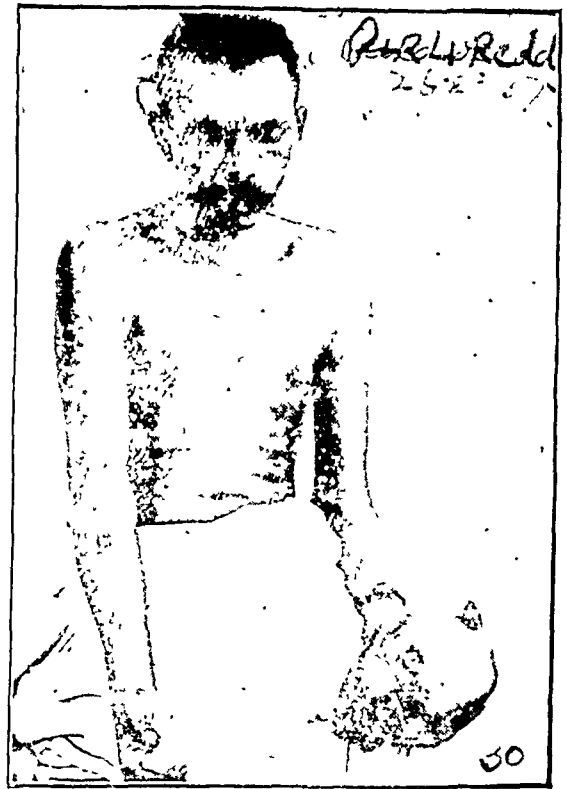


Fig. 32.

Clinical photograph showing the growth between the thumb and the index finger.

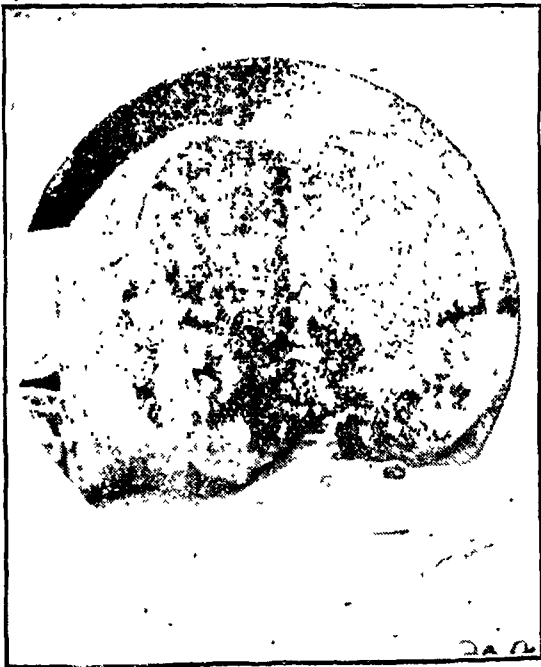


Fig. 32-a.

A section clinical photograph of the growth removed.

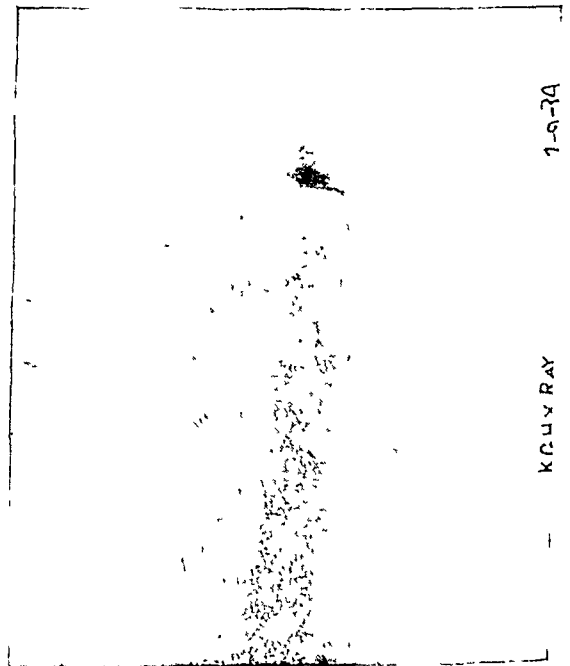


Fig. 33.

Radiogram of the whole aspect of the femur showing periosteal reaction with decalcification and the erosion of the cortex and beaking at the lower margin.

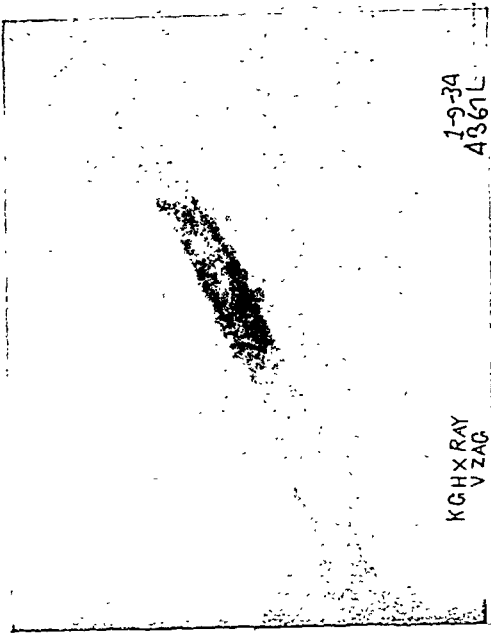


Fig. 33-a.  
Radiogram of the same case.

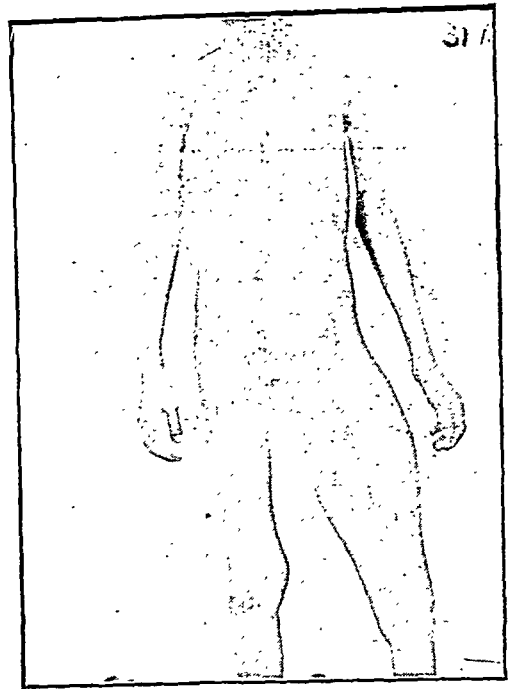


Fig. 33-b.  
Clinical photo of the thigh of the child.



Fig. 34.  
Radiogram showing the mottled appearance of the right side of the ilium.



Fig. 35.  
Clinical photo of the growth.



Fig. 36.

Clinical photo of the growth of the upper end of the humerus.

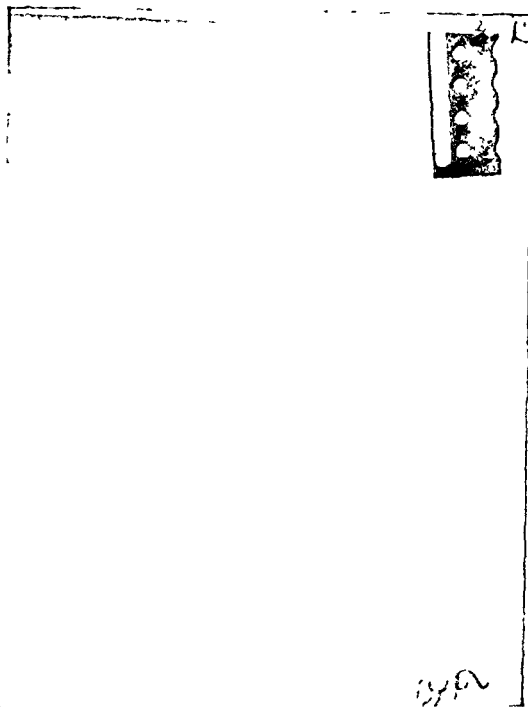


Fig. 37-b.

Is a radiogram showing a large irregularly oval rarefaction of the ala of the ilium.

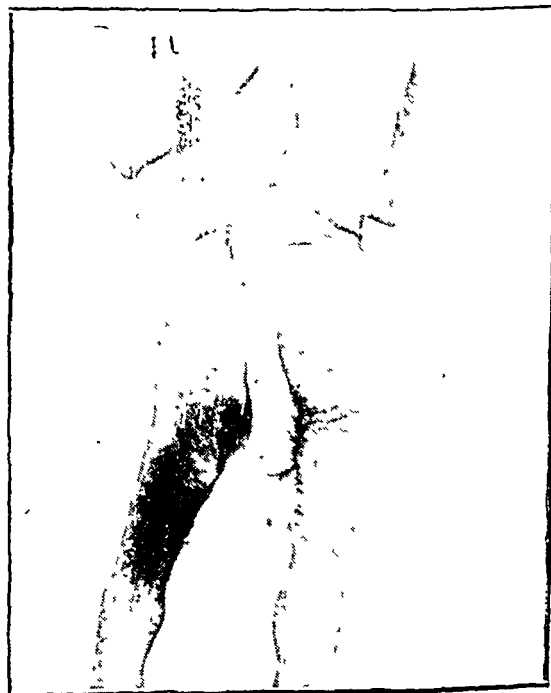
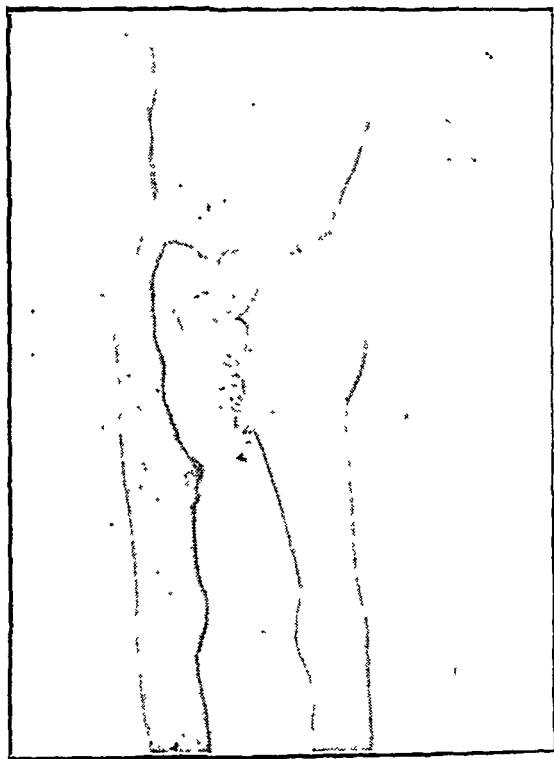


Fig. 37 & 37-a.

Anterio lateral and posterior view of the growth arising from the ilium.



Fig. 38.  
Shows secondary deposits in the lung.

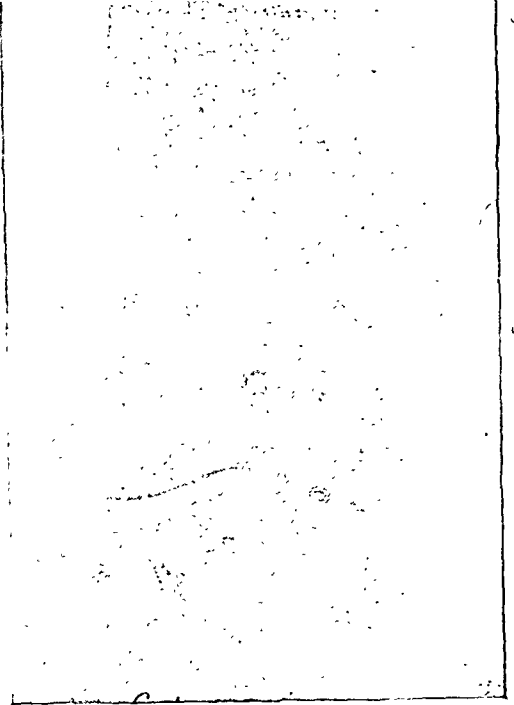


Fig. 39.  
Radiogram showing the rarefaction in the middle of the lower end of the metaphysis of the femur.

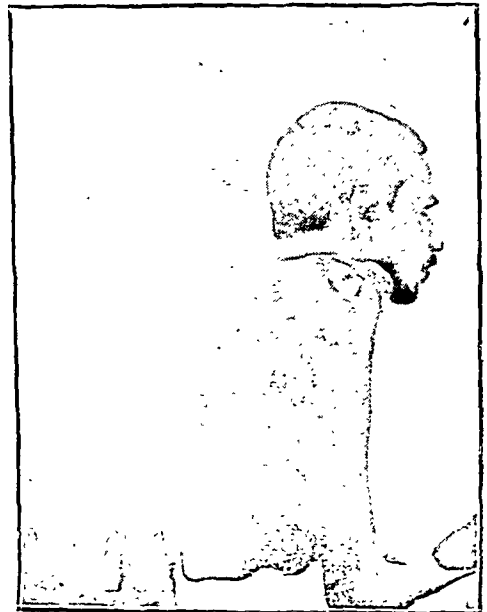


Fig. 38-a & 38-b.

are clinical photographs showing the ulceration of the growth and protrusion of the growth through the incision done mistaking it to be an abscess.

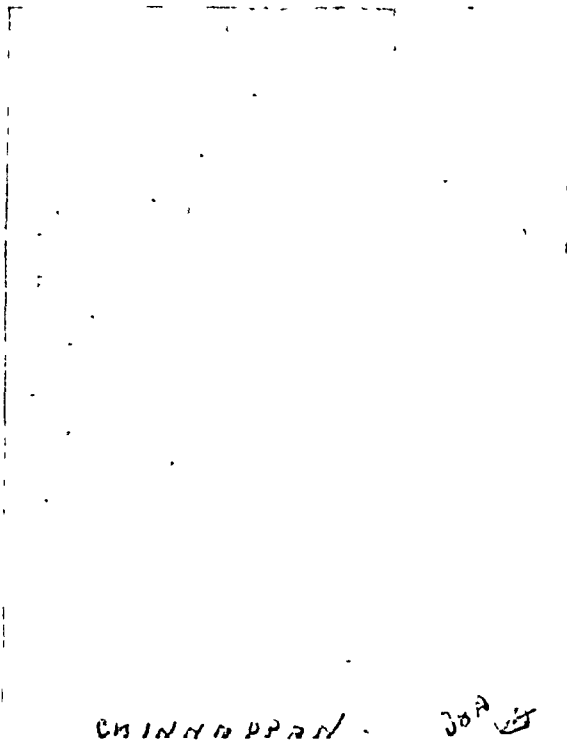


Fig. 39-a.

Radiogram showing the rarefaction in the middle and central aspect of the lower end of the femur.

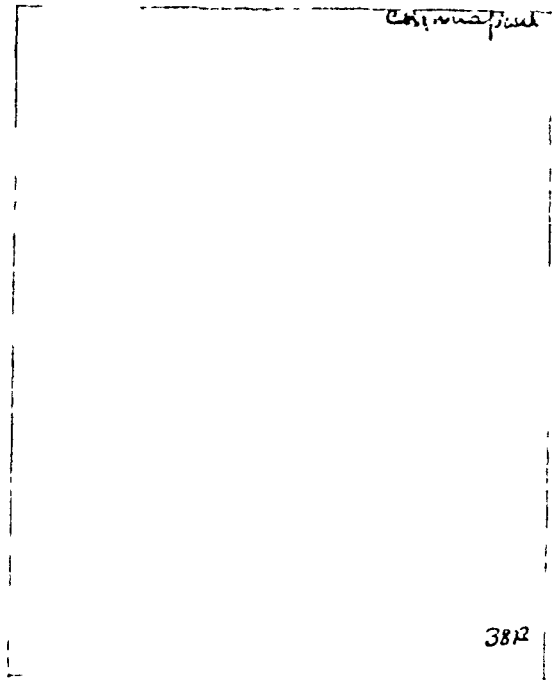


Fig. 39-b.

Shows rarefaction distinctly in the diaphysis of the lower end of the femur—lateral view.



Fig. 40.

Clinical photograph of a very big growth of the upper end of the humerus.

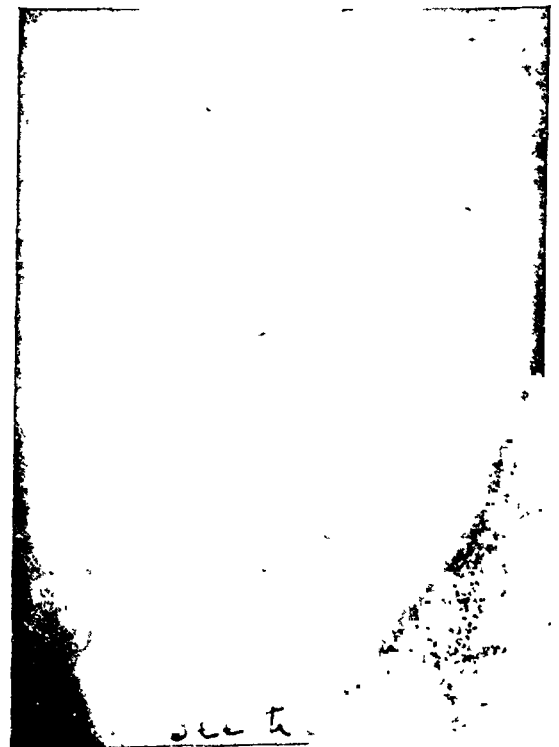


Fig. 41.

Radiogram showing the growth on the lateral aspect of the lower end of the femur with slight periosteal reaction below and showing the beaking above.

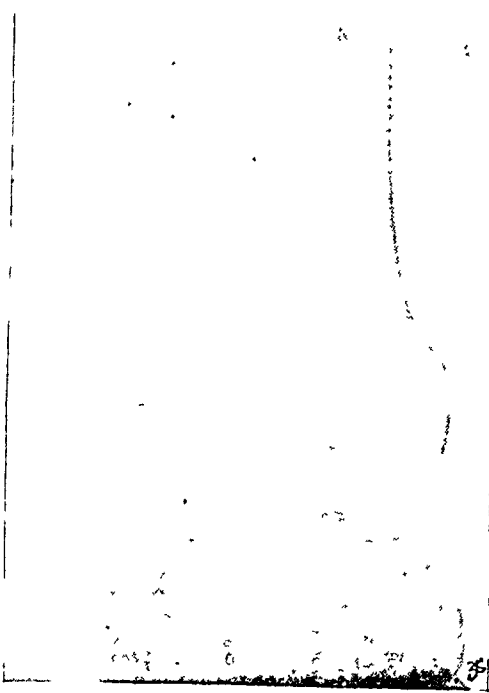


Fig. 42.

Shows the growth—rarefaction in the lower end of the femur, medial aspect.

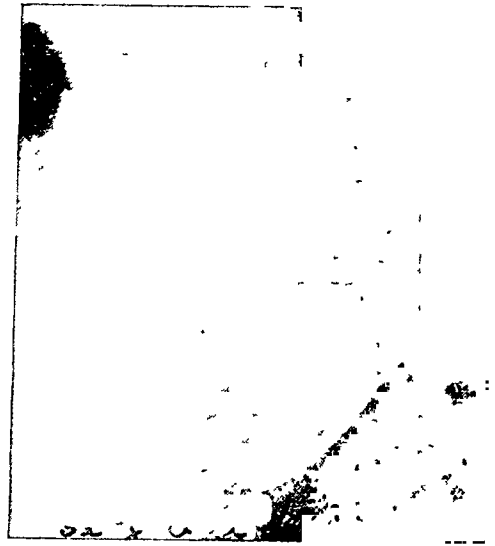


Fig. 43.

Radiograms showing the growth springing from the wing of the scapula—note the rarefaction.



Fig. 44.

Clinical photograph of growth from the upper end of the humerus.



Fig. 45.

Showing intense osteolysis of the diaphysis of the lower end of the femur with lifting of the periosteum as a ledge of bone.

# OSTEOGENIC SARCOMA

Serial No.	Name	Age & Sex	Duration	History	Bone and site and x-ray findings	Pathology report and investigations	Treatment	Result
1	Subhadramma Fig. 6.	20 yrs. H. F.	3 months	Started as a swelling, mistaken for an abscess and incised, since then bleeding from the wound at intervals.	Sarcoma, upper end of tibia with secondaries in left humerus & lungs.	After amputation-- Osteogenic sarcoma.	Amputation, thigh, at the junction of middle and lower third to relieve the smell and bleeding.	Died at home 3 months later due to secondaries in humerus and lungs.
2	Chinnayya	25 yrs. H. M.	1 year.	Started with pain first and later the swelling appeared. No trauma, general condition poor (sarcoma upper end of right tibia).	Upper end of tibia shows a growth with fine irregular trabeculation with no demarkation in the diaphysis below and metaphysis above.	No biopsy done.	Radium insertion-- total irradiation 6721 mgm hours.	Discharged otherwise.
3	K. Ramaswami Fig. 7 & 7a	60 yrs. H. M.	6 months.	Started as a small painful swelling which gradually increased in size.	Tumour affecting the lower end of right femur, pathological fracture of shaft of the bone, marked new bone formation in a radiating manner.	Post-mortem Osteogenic sarcoma.	P. M. Cause of death--Osteogenic sarcoma with secondary dissemination in lungs and brain.	Died
4	J. Paramma Fig. 8 & 8a	18 yrs. H. F.	6 months.	Started as a swelling, small, painful, upper end of right arm.	Destruction of the upper and middle third of the shaft of right humerus with new bone formation, periosteal in type with dense new bone formation extending almost to junction of middle and lower third.	Biopsy [done but result negative.	Exploration -- only blood was drawn.	Discharged otherwise-- Result not known.
5	M. Suri Fig. 9, 9a & 9b	15 yrs. H. M.	6 months. Iliac; 2 months L. shoulder 15 days L. temple.	Started as a painful swelling in the Left buttock followed by a swelling in the region of the right shoulder and later a swelling in the right temple.	Osteogenic sarcoma of right iliac bone and right humerus, secondaries on right side of skull. <i>Note:</i> characteristic features (iliac and humerus pictures are reversed while printing.)	Calcium 9.7 mg. per 100 c.c. serum; specimen of bone lost but skull kept in museum. P. M. Osteogenic sarcoma.	Interstitial radiation, 5689 mgm hrs. in the iliac bone; the swelling subsided but in the shoulder the swelling began to increase. This was done to try if tumour was radiosensitive.	Died: P. M. Large tumour in left ilium, metastasis in Rt. humerus & cranium. Lungs, kidney congested. Fatty degeneration of liver.



6	K. Appanna Fig. 10, 10a, 10b, 10c & 10d	18 yrs. H. M.	11 months.	Started a small swelling over inferior angle of right scapula which grew gradually, pain 12 days	Sarcoma, scapula, right.	W. R. + + After excision osteogenic sarcoma.	Excision of the tumour.	Osteogenic sarcoma histologically. Relieved—re-admitted 7 months later with recurrence over shoulder, thigh & pelvis; discharged otherwise as inoperable. Re-admitted again 2 mths. later with retention of urine—Died.
7	S Chinnayya Fig. 11 & 11a	18 yrs. H. M.	6 months.	Pain and swelling, right knee, increasing in severity.	Osteogenic sarcoma, lower third of right femur with typical sun-ray appearance.	Biopsy not done.	Advised amputation but refused.	Discharged otherwise—result not known.
8	Rajeswaramma	16 yrs. H. F.	1½ months.	Pain and swelling over the upper end of right tibia	Rt. tibia—x-ray shows rarefaction in centre with faint thin bone deposit parallel with the cortex.	W. R. + + Biopsy: The cytology is that of an endotheliomatous tumour sheets of polyhedral cells with rounded nuclei & scanty poorly staining cytoplasm without appreciable intercellular substance.	Tumour explored with a Trephine and closed. Deep X-rays.	Discharged otherwise; Advised to go to G. H. for deep x-rays. Reported died 3 months later. Had deep x-ray therapy.
9	N. Appanna Fig. 12 & 12a	50 yrs H. M.	2 months.	20 years a small growth between great and second toe; suddenly increased in size which ulcerated; Fungating Chondrosarcoma, foot, left.	Diffuse ossification over the whole of the mass and seems to arise from the head of the 1st metatarsal bone, right.	P. M. Ossifying chondro-sarcoma 1st metatarsal bone; had a duodenal diverticulum near ampulla of Vater.	Inoperable.	Died: Developed hemiplegia with gangrene foot & phlebitis 7 days after admission. P. M. done.
10	Seshamma Fig. 13 13a	16 yrs. H. F.	6 months	Painful swelling, right thigh.	Periosteal sarcoma, right femur, extending the whole length of right femur, typical sun-ray appearance.	Biopsy not done.	Advised disarticulation at hip, but refused.	Discharged otherwise, follow up, no reply.

# OSTEOGENIC SARCOMA (Contd.)

Serial No.	Name	Age & Sex	Duration	History	Bone and site and x-ray findings	Pathology report and investigations	Treatment	Result
11	M. Guruvagadu Fig. 14	25 yrs. H. M.	7 months.	Pain in the knee.	Osteolytic type of sarcoma, upper end of left tibia showing replacement of bony structure by tumour mass.	Biopsy not done.	Advised amputation but refused.	Discharged otherwise—follow up, no reply.
12	R. Seetharamamma Fig. 15 & 15a	15 yrs. H. F.	1½ months.	Started as a painful swelling on the medial side of the left knee which gradually increased in size, was cauterised.	Sarcoma, upper end of left tibia—Chest heart—dilated and boot shaped.	W. R. Negative Biopsy not done.	Advised amputation but refused.	Discharged otherwise—follow up, no reply.
13	Brindavan Patro Fig. 16, 16a, 16b, 16c, 16d, 16e, 16f & 16g	25 yrs. H. M.	2 years.	Started as a swelling which gradually increased in size; diminution of vision and hearing, right eye and ear, 2 months.	Skull shows fluffy appearance.	Biopsy not done.	Interstitial radiation. 1526 mgm. hours of radium given—at time of discharge growth showed signs of regression and became flat.	Follow up—no reply.
14	Veeranna Fig. 17 & 17a	20 yrs. H. M.	1 year.	Started as a painful swelling of the left knee following trauma; operated at Cocanada, swelling was removed; 6 months later it recurred.	Upper end of left tibia.	W. R. doubtful; Path: Chondrosarcoma showing typical cartilaginous nodules with large hyperchromatic cartilage cells.	Amputation, thigh junction of upper and middle third.	Relieved—no reply on follow up.
15	Chennamma Fig 18 & 18a	20 yrs. H. F.	6 months.	Started with pain in right knee and later swelling, no trauma.	Upper end. of right tibia.	Biopsy not done.	Refused amputation.	Discharged otherwise—no reply on follow up.
16	Ranganayakamma Fig. 19	16 yrs. H. F.	3 months.	Pain in the left knee increasing in severity 3 months.	Shows parallel patchy lamination suspicious of Ewings or Specific infection; had antisyphilitic treatment but no result.	W. R. Strong + Biopsy not done.	12 radium needles inserted into the bone after drilling (6620 mgm. hours) 12 needles into periosteum. Total 53 mgm. 8880 mgm. hours.	Relieved; Reported died of same disease 2 years later, 6 months after giving birth to a son. This boy is all right now.

17	Malliah Fig. 20 & 20a	22 yrs. H. M.	4 months.	Started with pain, lower part of thigh, right, followed by swelling and increasing pain.	Medulla shows in places cavitation lack of differentiation between cortex and medulla in the middle of the shaft of right femur, parallel lamination with periosteal, sun-ray appearance, suggestive of Ewing's sarcoma; No secondaries in lung, no other bones showed clinical evidence of deposits.	W. R. Negative. Aspiration biopsy—blood clot with shreds of tissue having the structure of a round cell sarcoma.	Exploratory puncture, blood stained fluid drawn which clotted without separation of serum. Another specimen contained whitish flakes. Advised amputation as there was not enough radium or x-ray treatment	Discharged otherwise—no reply to follow up.
18	Appanna	30 yrs. H. M.	3 months	Started with pain and swelling in the left knee joint.	There is periosteal separation bearing posteriorly and new bone formation; In the lateral view spicules of bone run into the soft tissues surrounding the bone. Periosteal sarcoma left lower end of femur Lungs: No definite evidence of secondaries in the lungs. Soft deposits in and around the right hilum.	Biopsy not done.	Advised amputation but refused.	Discharged otherwise—no reply to follow up
19	Nookalamma Fig. 21, 21a, 21b, 21c & 21d	40 yrs. H. M.	6 months.	Pain and swelling, right knee.	Right fibula shows erosion of cortex. Upper end of tibia show similar changes posterior aspect with evidence of new bone formation.	W. R. Negative Biopsy not done.	Radium implantation 9556 mgm. hours, result good at time of discharge.	Relieved—no reply.
20	Somulu Fig. 22 & 22a	25 yrs. H. M.	2 months	Started as painful swelling on the lateral side, left knee joint.	Erosion of Trigonal area of femur with beaking; new bone formation in front and lateral aspect	W. R. Negative Biopsy not done.	Advised disarticulation but refused.	Discharged otherwise.
21	Seshachalam Fig. 23 & 23a	28 yrs. H. F.	3 months.	Started as a painful swelling on the medial aspect of right knee after parturition; subsided after local treatment.	Osteolytic changes of right upper end of tibia, lateral aspect. Lungs: no secondaries.	Biopsy not done.	Advised amputation but refused.	Discharged otherwise—no reply on follow up.

# OSTEOGENIC SARCOMA (Contd.)

Serial No.	Name	Age & Sex	Duration	History	Bone and site and x-ray findings	Pathology report and investigations	Treatment	Result
22	P. Chinnamma Fig 24	30 yrs. H. F.	6 months	Swelling and pain, right knee one month after trauma.	Osteolytic changes upper end of right tibia with extension into shaft below. Note patchy bone formation outside cortex.	Biopsy not done.	Advised amputation but refused.	Discharged otherwise, result not known -- letter returned by D.L.O.
23	Janakiramayya Fig. 25	23 yrs. H. M.	1 year	Pain and swelling in the right iliac region shooting down the thigh and leg on the posterior aspect.	Sarcoma, right ilium involving the sacrum, secondary deposits in lungs.	Biopsy not done.	Inoperable.	Discharged otherwise, result not known -- letter returned by D.L.O.
24	Veeraswamy Fig 26 & 26a	35 yrs. H. M.	10 months	Started with pain, right knee following a sprain. One month later swelling appeared. It was branded by a native doctor resulting in ulceration	Sarcoma, femur -- shows osteolytic changes with irregular ossification.	W. R. Doubtful No biopsy done.	Advised amputation but refused.	Discharged otherwise, result not known -- letter returned by D.L.O.
25	Veeri Naidu Fig. 27 & 27a	25 yrs. H. M.	1 year	Pain and swelling over the dorsum of right fore-arm following trauma,	Irregular patchy bone deposits in a big tumour formation, seeming to arise from right ulna but showing involvement of shaft of radius also.	Biopsy not done.	Refused treatment.	Discharged otherwise, result not known
26	Bangaramma Fig. 28	25 yrs. H. F.	1 year	Started as a painful swelling fore-arm which ulcerated about three months ago.	Periosteal sarcoma radius sun-ray appearance seen.	Biopsy not done.	Refused treatment.	Discharged otherwise, result not known
27	K. Narasi Reddi Fig. 29, 29a & 29b	20 yrs. H. M.	5 months	Pain over the upper third of left humerus and swelling 2 months; haemoptysis 2 months.	Periosteal sarcoma, upper end of humerus; Lungs: marked secondary deposits right plura and lung secondary deposits, left lung.	Biopsy not done.	Inoperable.	Discharged otherwise, Reported dead one month after discharge

28	K. Malleu Fig. 30	14 yrs. H. M.	3 months.	Pain and swelling, left shoulder.	Periosteal sarcoma, upper end of left humerus with marked beaking.	Biopsy not done.	Inoperable.	Discharged otherwise—result not known.
29	R. Sundari Fig. 31	25 yrs. H. F.	1 year.	Started as a small nodule near the upper alveolar margin.	Maxillary antrum on left side opaque, sarcoma, maxillary, left.	W. R. Negative Biopsy after excision—osteogenic sarcoma.	Radium implantation 15 mg. 1725 mgn. hours—no effect; later excision done.	Discharged relieved—Result of follow up—letter returned by D. L. O.
30	Pirli Reddy Fig. 32 & 32a	35 yrs. H. M.	1 year.	Swelling started between index and thumb, grew to the size, painful and tender, was branded.	X-ray shows 2nd metacarpal entirely replaced by tumour tissue.	Biopsy not done—Pathology report—Myxo chondro sarcoma after amputation.	Amputated.	Follow up—alive after one year.
31	Sabavarappu Devudu Fig. 33, 33a & 33b	7 yrs. H. M.	2 years.	History of trauma with increasing swelling.	Appearances suggestive of periosteal sarcoma, shaft of femur, left.	Biopsy—only blood drawn.	Refused disarticulation.	Discharged otherwise—result not known.
32	G. Satyanarayana Fig. 34	56 yrs. H. M.	9 months.	Pain in hip—limitation of flexion.	Osteogenic sarcoma, ilium.	Biopsy not done.	Poor condition.	Discharged otherwise.
33	Bangariah Fig. 35	20 yrs. H. M.	6 months.	Pain and swelling, left shoulder	Osteogenic sarcoma, upper end of left humerus	Biopsy not done.	Poor condition.	Discharged otherwise.
34	Chinnayamma Fig. 36	25 yrs. H. F.	6 months.	Swelling, shoulder, 6 months duration.	X-ray not taken. Upper end of humerus.	Biopsy not done.	Advanced case.	Discharged otherwise.
35	Latchayya Fig. 37, 37a & 37b	50 yrs. H. M.	9 months.	Pain in the region of left hip	X-ray shows osteolytic type of sarcoma, ilium, left.	Biopsy not done.	Poor condition.	Discharged otherwise.
36	Ramiah	30 yrs. H. M.	6 months.	Painful swelling, right upper end of tibia.	Osteolytic type of sarcoma of right upper end of tibia.	Biopsy not done.	Radiation—refused amputation.	Result poor—discharged otherwise.
37	Sundara Row Fig. 38, 38a & 38b	23 yrs. H. M.	3 months.	Six weeks back had an accident, later pain, had electric massage, later incised in a Hospital with increase in swelling, pain and smell.	X-ray shows osteolytic sarcoma of spine and acromian process of right scapula with secondaries in lung.	Biopsy not done.	Inoperable.	Discharged otherwise—result not known.
38	Chinnappan Fig. 39, 39a & 39b	20 yrs. H. M.	3 months.	Pain in the left knee following trauma, 3 months ago.	Osteolytic sarcoma, lower end of left femur.	Aspiration biopsy—only blood clot and fibrin.	Pre-operative x-ray therapy.	Discharged otherwise result not known.

# OSTEOGENIC SARCOMA (Contd.)

Serial No.	Name	Age & Sex	Duration	History	Bone and site and x-ray findings	Pathology report and investigation	Treatment	Result
39	R. Ramaswamy Fig. 40	18 yrs. H. M.	6 months.	For pain in shoulder with swelling which began to increase after country thermo cautery.	Clinical photo present. X-rays were not taken. Sarcoma, humerus, right	Biopsy not done.	Nil.	Discharged otherwise as it was an advanced case of sarcoma—result not known.
40	Seetharamamma Fig. 41	18 yrs. H. F.	6 months.	Painful swelling, left knee, medial aspect of thigh, massaged for 1 month. Another swelling over left temple of the size of an egg, 20 days duration.	Appearance suggestive of osteogenic sarcoma, Left femur, lower end.	Aspiration biopsytive. Osteogenic sarcoma.	Advised amputation but refused.	Discharged otherwise—result not known.
41	Gopal Rao Fig. 42	21 yrs. H. M.	25 days.	Pain in the right knee, no definite history of trauma, effusion.	Osteogenic sarcoma, lower end of right femur, erosion of cortex with decalcification with pathological fracture.	Aspiration biopsy; shows collection of spheroidal shaped cells and a few malignant round cells with blood clot suggestive of osteogenic sarcoma.	Refused amputation.	Discharged otherwise—reported dead 6 months later.
42	Satyanarayana Fig. 43	30 yrs. H. M.	9 months.	Started as a small swelling in the region of left shoulder.	Left scapula (No. 5311 dated 28-11-1946).	Aspiration biopsy—appearance suggestive of Ewing's sarcoma.	Deep x-ray therapy given	Discharged otherwise.
43	Raja Narasimha Rao Fig. 44	32 yrs. H. M.	3 months	Painful swelling, right shoulder.	Appearance suggestive of osteogenic sarcoma of right humerus, upper third.	Biopsy not done.	Deep x-ray therapy.	Not much improved—result not known.
44	Munuswamy Fig. 45	21 yrs. H. M.	3 months.	Pain in the left knee following trauma.	Osteogenic sarcoma, lower end of femur, left.	Aspiration biopsy unsuccessful.	Advised amputation.	Discharged otherwise—result not known.

45	Lalitha	15 yrs. H. F.	2 months.	Started with pain and effusion in left knee joint.	Outer table of cortex of the lower end of left femur eroded, new bone formation + +; appearance suggestive of osteogenic sarcoma. Lungs—small rounded opacities suggestive of secondaries.	Biopsy not done.	Inoperable.	Discharged otherwise—result not known.
46	Manickam	21 yrs. H. M.	6 months.	Pain and swelling round knee and lower end of thigh.	Femur, left (No. 2130 dated 28-11-1946).	Aspiration biopsy shows groups of pleomorphic cells polyhedral and spindle shaped and a few large single giant cells hyperchromatic and plenty of intercellular material suggestive of osteogenic sarcoma.	Advised amputation but refused.	Discharged otherwise.
47	Srinivasan	25 yrs. H. M.	23 days.	History of injury 2 years ago, pain 23 days ago, acute pain and swelling upper end of left tibia.	X-ray appearance—suggestive of osteogenic sarcoma, upper end of left tibia.	Aspiration biopsy suggestive of osteogenic sarcoma.	Advised amputation but refused.	Discharged otherwise—result not known.
48	E. Appanna	30 yrs. H. F.	6 months.	Started as a small swelling on the middle phalanx of the middle finger, left and gradually grew to the size of an almond.	Chondro sarcoma, finger. There is destruction of bone suggestive of sarcomatous change.	After amputation Chondro sarcoma.	Amputation of left middle finger.	Good at time of discharge—follow up—result not known.
49	Venkateswaralu	17 yrs. H. M.	4 months.	History of trauma 4 months ago, since then unable to use his left knee.	Secondaries are visualised in the lung field.	Osteogenic sarcoma, lower end of left femur.	Amputation through the upper third of thigh.	Relieved—No reply to letter.

## OSTEOCLASTOMA

Seventeen proved cases of osteoclastoma are reviewed. The cases that came for diagnosis and treatment were definitely more but are not reported as some did not consent for any further investigation and treatment. Such cases have been excluded from this paper. Only clinical, radiological and therapeutic aspects are dealt with.

### AGE INCIDENCE AND DURATION

The age incidence as noted was between the years of 35 and 40 except in cases where this occurred in the small long bones, i.e., the metacarpals, metatarsals and phalanges. In these situations it occurred in younger people.

The duration in all cases was long, usually over six months. Sometimes it was difficult to get a correct assessment of the duration due to illiteracy of the public. Sometimes growths which occurred in younger people, in the situations mentioned above, grew more rapidly and hence the patients came to the surgeon earlier.

### RELATION OF TRAUMA TO TUMOUR

A very curious feature about these bone tumours is the relation of the trauma to the tumour. 12 out of the 17 cases gave a definite history of injury prior to the onset of swelling or pain. In the case of Osteoclastoma of the sacrum (case No. 6) the patient definitely gave a history of a fall from his bicycle landing on his buttocks and due to the pain he was X-rayed to exclude a possible fracture in the region of the sacrum which was negatived.

### DIFFICULTIES IN DIAGNOSIS

It is difficult to diagnose osteoclastoma in the earlier stages. Sometimes a history of a previous accident with subsequent pain makes them seek the advice of a doctor or these growths are accidentally discovered after a roentgenography when they come for pain or a swelling. In atypical borderline types of cases, it becomes a difficult

problem. A comprehensive review has to be taken after doing specialist types of investigations such as x-ray, blood and biochemical examinations and aspiration and incision, or aspiration or trephine (Turek Trephine) biopsy as a routine before arriving at a diagnosis.

### ATYPICAL CASES SHOWING DIFFICULTY IN DIAGNOSIS

The following cases show that we cannot solely depend on radiography for diagnosis :

1. A Christian girl aged 16 years with a fusiform type of tumour extending from the upper third to the junction of the middle and lower third of the shaft of the humerus on the left side was admitted. X-ray appearance was suggestive of osteoclastoma; aspiration biopsy was negative. On removal, the pathologist's report was Osteitis Fibrosa Cystica. Her blood calcium was within normal limits and no enlargement of parathyroid was felt and no exploration was done and she is under observation after excision and bone graft operation. (Fig. 46 & 46-a.)

2. A Christian, male, a law student, aged 26 years, came with a tumour of the right femur with a pathological fracture. Aspiration biopsy was negative. The patient was treated for the supracondylar fracture of the femur. He was treated by skeletal traction using a Bohler's pin through the upper end of the Tibia and was treated by deep x-rays. On re-xray the tumour appeared calcified and the fracture showed healing. After a period of 9 months, x-ray showed that the fracture had united. This case was shown as an example of osteoclastoma causing pathological fracture even though aspiration biopsy was negative. (Fig. 47.)

### ASSESSING THE ONSET OF MALIGNANCY

It is well known that these tumours in a certain proportion of cases undergo malignant transformation. It is very difficult to say whether at any time a particular case under treatment has undergone malignant



change or not. It is stated by the Radiologists that the clear cut curved line of demarcation in the shaft when it becomes ill defined, can be considered to be a sign of malignancy along with proliferative reaction of the periosteum.

#### ROLE OF DEEP X-RAYS

The surgical procedure of excision and bone graft was done in most cases when growth was considered fit for excision in the earlier stages. It was the experience that the tumour which had softened in areas spilt during dissection and a lot of care had to be exercised while dissecting out this tumour. One case which was considered malignant on radiological grounds was subjected to x-ray treatment and after three months was partially amputated using Chopart's technique with modification. Even though the tumour was big and the skin was stretched over it, it was found easier to dissect it without spilling after radiation. Based on this experience, routine irradiation of the tumour before excision is suggested. The underlying idea is—

- (a) to eliminate any radio sensitive tumours thus acting as a check on the diagnosis;
- (b) it is of the nature of a therapeutic test; and
- (c) it helps the dissection of the tumour making subsequent operation technically easier.

#### THE VALUE OF ASPIRATION BIOPSY

Aspiration biopsy is an aid in establishing the diagnosis. It is very difficult for us to state whether the dangers of biopsy are real or not. So far there have been no adverse effects after doing these biopsies. The aspiration biopsy sometimes is not helpful. This may be due to faulty technique in aspiration or suction. The aspiration biopsy if successful may help in determining the onset of malignancy, but it must be remembered the converse is also possible, the aspiration or suction biopsy may be from a region of the tumour showing only benign cells even though the tumour is defi-

nately malignant (case No. 15). The use of Turkel Trephines has been a distinct advance in aspiration biopsy.

#### OUR PRESENT POSITION

The position to which we have arrived in the treatment of these osteoclastoma can be summarised thus:—

- (1) routine clinical examination.
- (2) examination of urine for albumin, Bence Jones protein etc.
- (3) examination of blood for Wasserman, blood chemistry especially blood calcium and blood phosphatase, blood picture.
- (4) plain x-ray.
- (5) aspiration, incisional or Turkel Trephine biopsy.
- (6) preliminary deep x-rays.

*The treatment adopted in the unit is as follows:—*

1. In the beginning when deep x-ray facilities were not available, radiation with interstitial implantation were tried with poor results. Cases Nos. 2 and 6.

2. Radical local excision and bone graft. Usually done as one stage operation but may have to be done in two stages. The indications for doing in two stages are either shock or sepsis (Cases Nos. 9, 12, 14 and 15) No. 15 proved a sarcoma and after excision the case is under observation before bone grafting is undertaken.

(a) In one case, the patient was shocked before the bone graft could be taken and the grafting was done later (Case No. 9).

(b) In one case there was definite sepsis, the patient having come with an ulcerated growth and when the operation was done in one stage, the graft got infected and came away partly as a sequestrum. Though the wound healed by first intention a fortnight after removal of stitches, the patient began to run a temperature with pain. Ultimately, the graft had to be removed as a sequestrum. With this experience it has been decided not to do excisic

grafting at one stage but defer it if there is a focus of sepsis nearby (Cases Nos. 10 and 15).

3. Sometimes mere excision is done in certain situations. Case No. 11—upper end of Fibula was excised and grafting was considered superfluous in this case. Sometimes mere excision with re-construction is the operation of choice as in Case No. 17 where there was a pathological fracture in the neck of the Femur.

4. Amputations are done in cases which are not amenable to excision. The following types of amputations were done.

(i) Chopart's amputation with modification. Case No. 1 for metatarsal growth. Case No. 8.

(ii) Removal of a finger when the growth is limited to a finger or metacarpus. There was only one case of this type but it is being treated by x-ray. Case No. 16.

(iii) In gross involvements amputation at the seats of election. (Cases Nos. 2, 3 and 7).

5. Excision with diathermy knife. Case No. 4.

6. Deep x-ray treatment only. This is under investigation. Case No. 16.

A tabular statement of 17 cases with follow up notes wherever possible is appended to this paper.

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CASE NO 1451

Fig 46

Radiogram showing the cystic condition of the diaphysis extending from the junction of middle and upper third extending down the shaft to junction of middle and lower third—note the soap bubble appearance

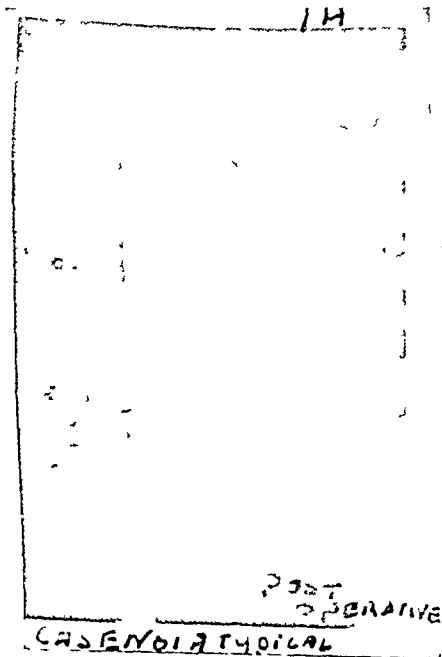


Fig 46-a

Radiogram showing the graft put in after excision of the growth.



Fig 47

Radiogram showing the healed supra-condylar fracture of the lower end of the femur—note the soap bubble appearance.



Fig. 48.

Shows the lateral view but the cavitation is marked though thickening is greatly seen in the upper part of the tumour—this is a post radiation picture.

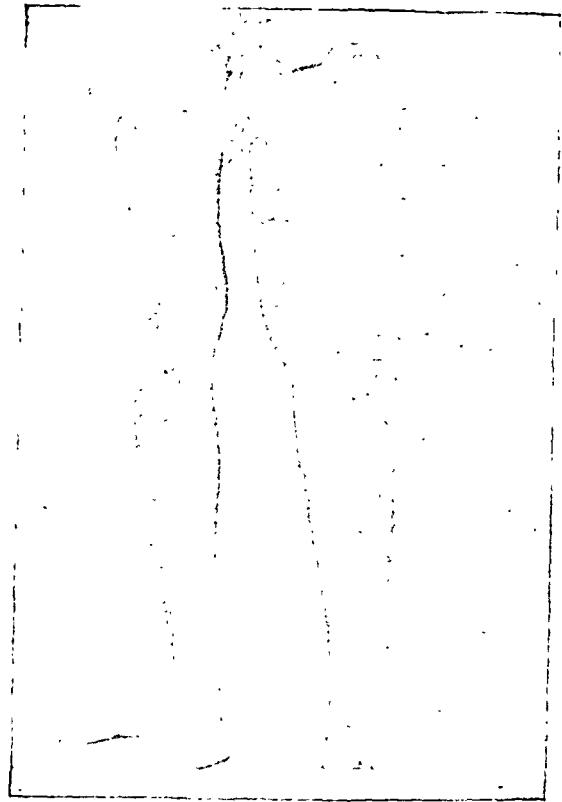


Fig. 49.

Is a clinical photograph showing the growth in the lower end of the femur.



Fig. 49-a.

Radiograph picture taken of the amputated specimen—note the enormous size of the growth and the end of the bone projecting into the growth appears to be normal and uniform.



Fig. 50.

Shows the growth in the region of the maxilla on the left side.



Fig. 50-a.

Shows expansion of the growth after waiting for some days in the hospital.



Fig. 50-b.

Is a clinical photograph taken after diathermy excision of the growth—note regression of the growth.



Fig. 51.

Is a clinical photograph showing the growth in the lower end of the radius.

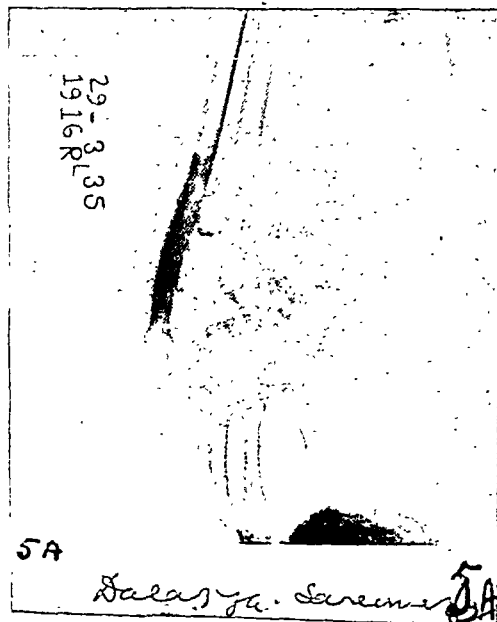


Fig. 51-a.

Radiogram showing the typical appearance of the growth—it was suspected to be malignant case from the size of the growth.

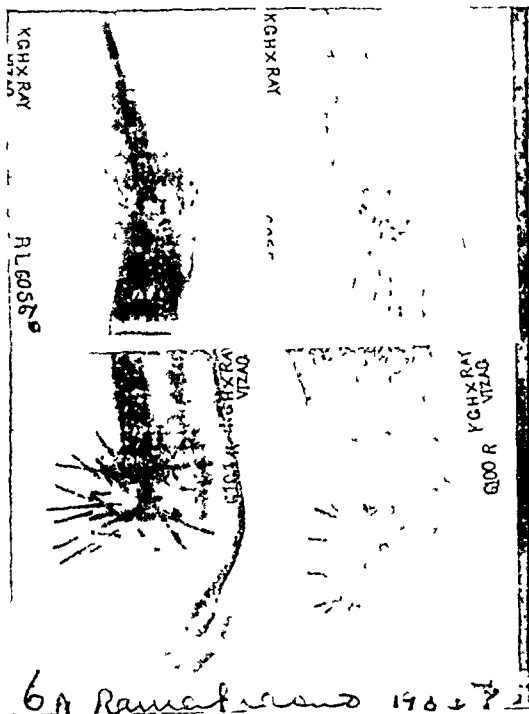


Fig. 52.

Two radiograms—show the size of the growth in the lower end of the radius.

Fig. 52-a.

Two radiograms show the radium needles in situ—appearance suggestive of osteo-clastoma

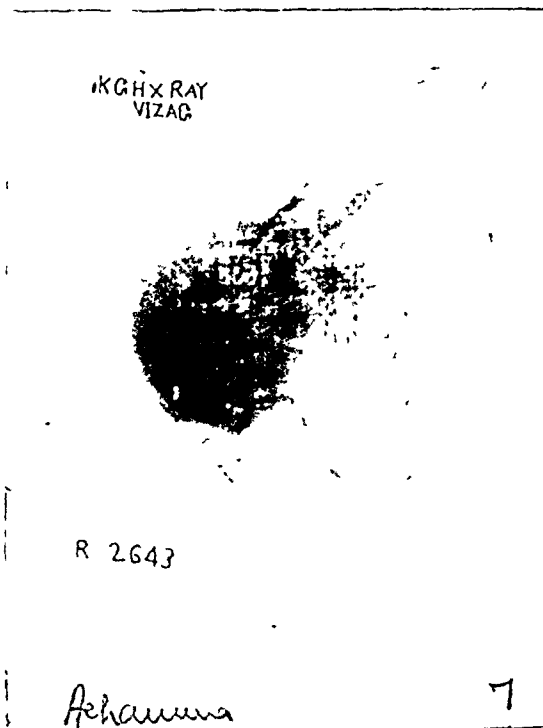


Fig. 53.

Shows the enormous growth dense in character showing the end of the bone overlapped by the tumour.

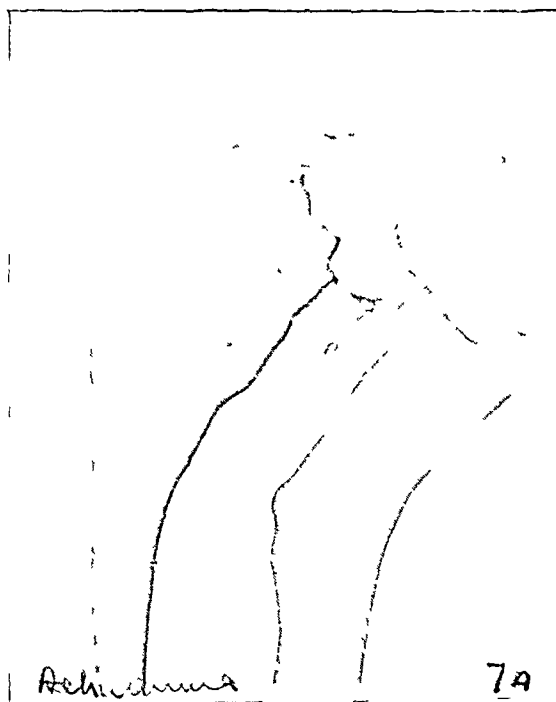


Fig. 53-a.

Clinical photograph of the growth—note the size of the growth.

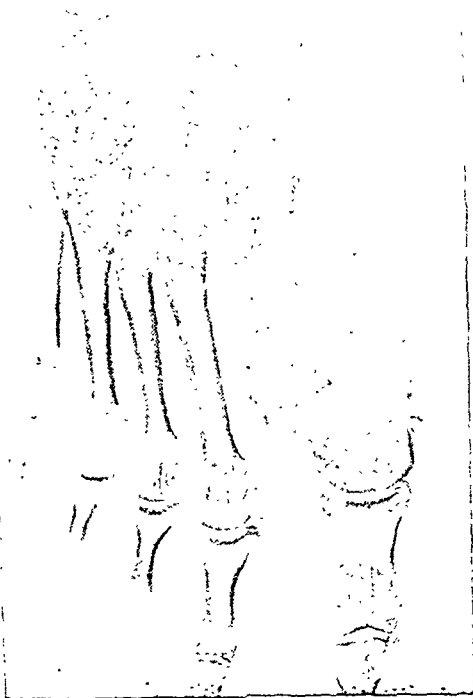


Fig. 54.

Radiogram showing the first metatarsal is entirely replaced by tumour tissue—head of the first metatarsal is appreciable but the rest of the bone is not appreciable.



Fig. 54-a.

Is a clinical photograph showing the result of modified Chopart's amputation.



Fig. 55.

Radiogram showing growth in the upper end of the humerus—note the size of expansion and also the rarefaction occurring in the shaft of the bone adjacent to the tumour. This proved to be benign histologically and at follow up.



Fig. 55-a.

Radiogram showing the result after 1 year—note absorption of the graft in its proximal part

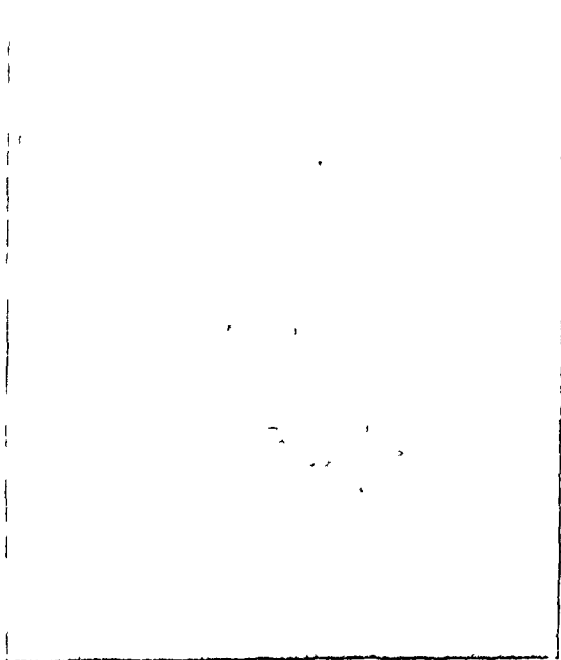


Fig. 56

Shows the typical appearance of osteo-clastoma in the lower end of the tibia—A P view.

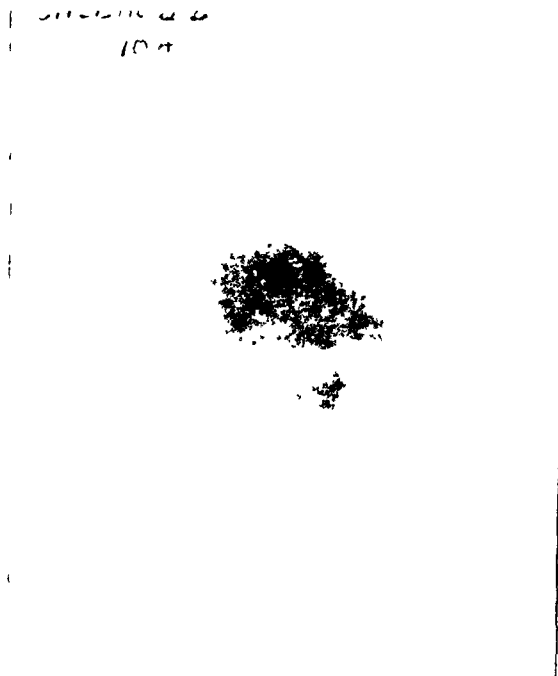


Fig. 56-a.

Lateral view.



Fig. 56-b.

Radiogram showing after excision of the growth and bone graft—note the density of the graft below and separation from the proximal part of the graft showing the graft has sequestered.

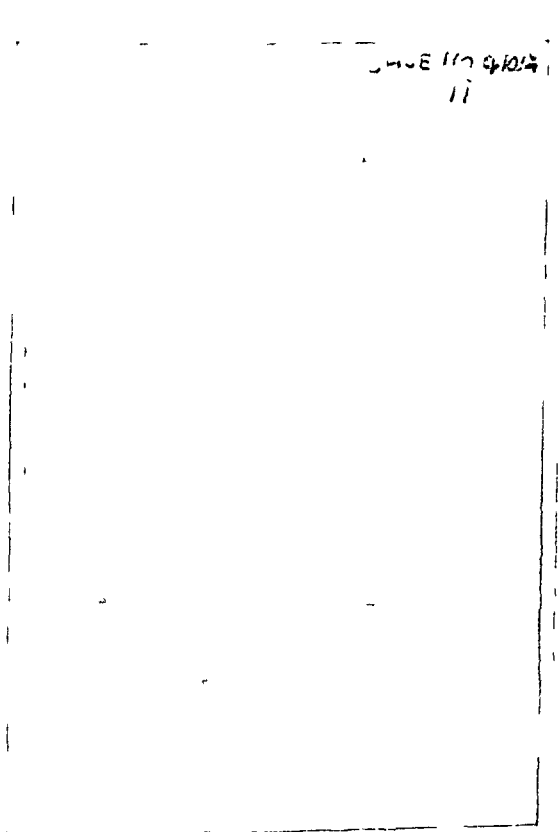


Fig. 57.

Radiogram showing typical appearance of osteo-clastoma of the upper end of fibula





Fig. 57-a.

Radiogram showing after excision of the same.



Fig. 58-a.

Radiogram after excision of the growth and bone graft—note bone graft has taken well.

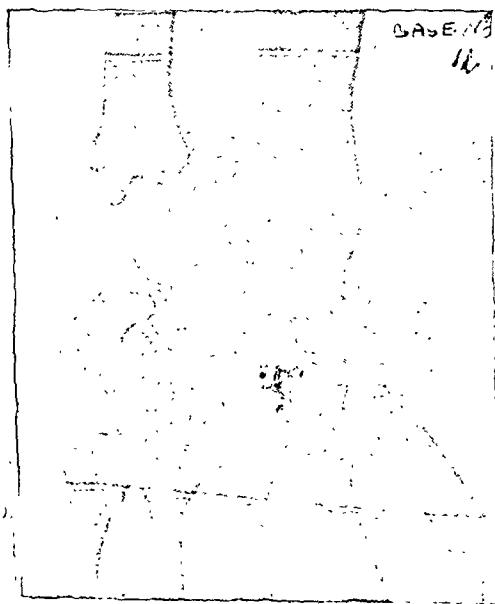


Fig. 58.

Radiogram showing osteo-clastoma in the lower end of the radius.



Fig. 59.

Radiogram showing the osteo-clastoma in the lower end of the ulna.



Fig. 59-a.  
Radiogram after excision of the growth and bone graft.

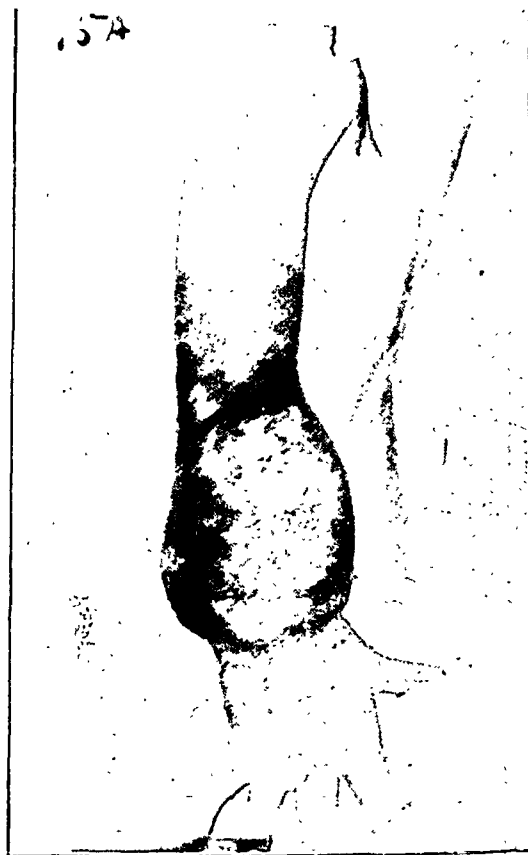


Fig. 60-a.  
Clinical photograph—A.P. view of the growth.

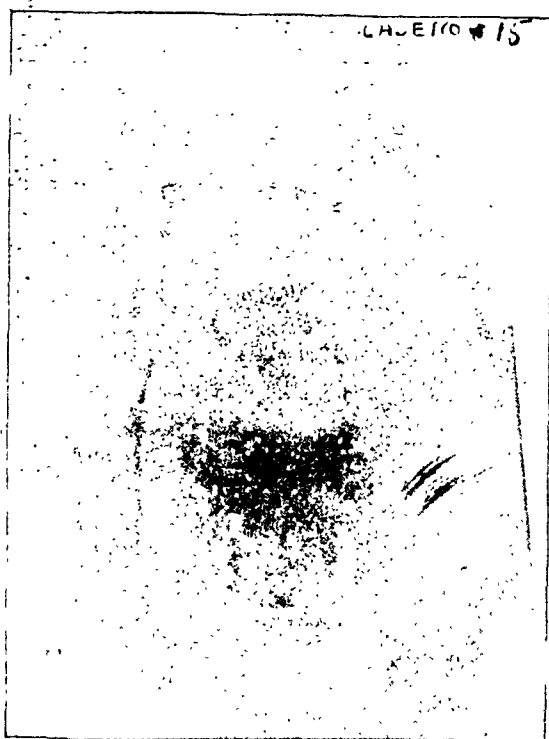


Fig. 60.  
Radiogram showing big sized osteo-clastoma lower end of the radius.



Fig. 60-b.  
Clinical photograph—lateral view.



Fig. 60-c.  
Radiogram taken after radiation.



Fig. 60-d.  
Radiogram taken after excision.



Fig. 61.

Growth seen in the 4th metacarpal of the hand—note the 4th metacarpal is entirely replaced by the growth except at the distal end of the bone.



Fig. 62.

Is a radiogram showing the pathological fracture. Note the cystic evidence in the neck of Femur.



Fig. 62-a.

Is a radiogram after reconstruction of hip.

# OSTEOCLASTOMA

Serial No.	Name	Age & Sex	Duration	History	Bone and site and x-ray findings	Pathology report and investigations	Treatment	Result
1	Gopalakrishna	36 yrs. H. M.	1 year	History of accident, twisting of his knee	Upper end of left tibia-x-ray appearance suggestive	Biopsy not done	Advised local excision and bone graft	Discharged otherwise.
2	K. Rahaman Fig. 48	27 yrs. H. M.	3½ years	History of accident, was operated in Rangoon, gouging and scraping	Lower end of left femur. Typical x-ray appearance	Biopsy not done, Rangoon diagnosis—Osteoclastoma	Radiation done to return at 1 year's interval	Discharged otherwise as the tumour did not show any regression though there was calcification. Advised amputation, later heard he was amputated elsewhere.
3	Radha Fig. 49, & 49a	30 yrs. H. F.	1 year	While carrying a load she fell and sustained an injury to the lower and left thigh	Lower end of left femur x-ray was taken after amputation	Biopsy not done, after amputation Osteoclastoma	Amputation seat of election	Patient reported three years after operation that she was well.
4	Subba Rao Fig. 50, 50a & 50b	30 yrs. H. M.	3 years	No history of accident	Left upper jaw; x-ray not definite	Biopsy not done, after excision Osteoclastoma	Complete diathermy excision	Patient reported 2 years after operation with no recurrence.
5	Dalayya Fig. 51, 51a	40 yrs. H. M.	2 years	History of trauma, 3 years before	Lower end of right radius; shows marked expansion of bone with faint trabeculation	Biopsy not done	Advised amputation but refused	Discharged otherwise; follow up not possible; letter returned from D. L. O.
6	Ramaprasad Fig. 52, 52a	45 yrs. H. M.	6 months	History of fall	Lower end of right radius; shows marked expansion of bone with trabeculation	Biopsy not done	Interstitial radiation 9822 mgm. hours	Not favourable reaction; follow up not possible. Letter returned from D. L. O.
7	Achamma Fig. 53, 53a	35 yrs. H. F.	1 year	History of injury	Lower end of femur; shows very marked expansion with fine trabeculation	Biopsy not done, after amputation Osteoclastoma	Amputation seat of election	Letter returned from D. L. O.
8	Puṭṭanayya Fig. 54, 54a	22 yrs. H. M.	1½ months	No history of injury	Metatarsal; The whole of metatarsus replaced by tumour except the distal end where fine trabeculation is seen	Biopsy not done, after excision Osteoclastoma	Modified Chondroplasty	Good result. Three years after operation wrote that he was all right and the stump was functioning well.

Serial No.	Name	Age & Sex	Duration	History	Bone and site and x-ray findings	Pathology report and investigations	Treatment	Result
9	Meenakshi Fig. 55, 55a	22 yrs. H. F.	1½ months	Definite history of fall on left shoulder	Upper end of humerus; the whole of upper end replaced by tumour faint trabeculation	Biopsy not done, after excision Osteoclastoma	Excision, bone graft in 2 stages, graft was from fibula	Graft got absorbed partially especially in the proximal portion; Reported for follow up in November 1943; shoulder movements poor; advised 2nd operation of arthrodesis with bone graft but refused.
10	Somanna Fig. 56, 56a & 56b	40 yrs. H. M.	6 months	Definite history of local injury, knocked against a stump of wood	Lower end of tibia; typical radiological appearance	Biopsy not done, after excision Osteoclastoma	Excision with Talus, a sliding type of bone graft done & impacted into Os calcis to restore continuity.	Pt had come late with sinuses, graft got infected though initially healing by first intention occurred. Part of graft came away as sequestrum; part of it took. He left hospital walking with a slight limp after a 2 years stay in hospital. No follow up available.
11	Jeddy Fig. 57, 57a	37 yrs. H. M.	1 year	History of injury	Upper end of fibula; typical radiological appearance	Biopsy not done, after excision Osteoclastoma	Excision	Good result; Follow up no reply to p.c. written on 22-7-1947.
12	Manickamma Fig. 58, 58a	40 yrs. H. F.	6 months	Definite history of injury	Lower end of radius; typical radiological appearance taken 4 months before admission, expanded further at time of operation	Biopsy not done, after excision Osteoclastoma	Excision and bone graft from tibia	Very good result; fairly good functional result; Reported last on 6-10-45; Reported to p.c. sent on 22-7-47. No recurrence, no pain, able to do most household work
13	Devasirvatham	42 yrs. H. M.	1 year	Fall from cycle on his back, early suspected fracture	Last two pieces of sacrum is thinned out and markedly concave	Biopsy not done, after excision Osteoclastoma	Attempted excision	Shock due to haemorrhage after operation — death. There was no blood bank to relieve the shock.
14	Perumalswami Fig. 59, 59a	37 yrs. H. M.	1½ year	No history of injury	Lower end of ulna; typical radiological appearance of an x-ray taken 1 year before—Bone	Biopsy not done, after excision Osteoclastoma	Excision and bone graft from tibia	Very good result; excellent function reported for follow up on 29-7-47.

15	Ganapathy Fig. 60, 60a, 60b, 60c & 60d	36 yrs. H. M.	1 year	No history of injury	Lower end of radius; typical appearance	Biopsy done Osteo- clastoma; after excision Sarcoma	Under treatment having deep x-rays prior to Surgery; had three blood tra- nsfusion	Readmitted Jan 1948; General condition good; Good calcifica- tion of tumour; Wide excision of radius done using ulna as a tem- porary graft Patho- logical report—sar- coma.
16	Kathavarayan Fig. 61	18 yrs. H. M.	1 month	Lifted heavy weight, attributes his trouble definitely to acci- dent	IV Metatarsal left; marked expansion of 4th metacarpal very faint trabe- culation	Biopsy Osteocla- stoma	Treated by deep x-ray therapy	Under investigation and observation; watching the result of radiation.
17	Mr. Anandathirtha Rao admitted on 31-1-46 Fig. 62 62a	42 yrs. H. M.	Pain one year Fracture 10 days	No definite history of accident Serum protein 6.85 mgs% Calcium mgs% Inorganic phosphate 5 mgs%	Pathological frac- ture due to Osteo- clastoma? There was no other evi- dence of similar condition in other long bones.	After excision Osteoplastoma	Excision; Whit- man's Recon- struction	Good result at the time of discharge.

## DISCUSSION

*Dr. R. Mahadevan:* 1. As is known only too well, patients usually come to hospitals in very advanced stages of these conditions. Figs. 1-4 show clinical photographs and reprints of skiagrams of a patient with an osteogenic sarcoma of the maxilla. A glance at the figures will show that treatment in any form is out of the question.

2. The American Registry of bone sarcomas is an authoritative publication. According to the findings therein osteogenic sarcomas are usually very painful and the progress of the disease is such that it is unusual for the patient to resort to treatment earlier than a month or later than a year. (b) They do not occur in the aged, unless

into the cavity. This method is said to favour early healing and lessens the period of convalescence. (Year Book of Surgery, 1944).

4. *Traumatic cyst of skull.* The clinical photographs (Figs. 5 to 7) show a case of what may be described as a "traumatic cyst of skull." The patient at the age of 10 sustained severe injuries in a railway accident, resulting in crushed right foot, injuries to face, forehead, etc. 15 years later (in 1935), she reported to hospital with a large swelling in the forehead (Fig. 5), which was first noticed at the root of the nose 7 months previously. It was bony hard in the lower part while the upper part was thinned out and yielding. She had also condylomata of the vulva, which healed with antisyphilitic treatment. The forehead swell-



Fig. 1.

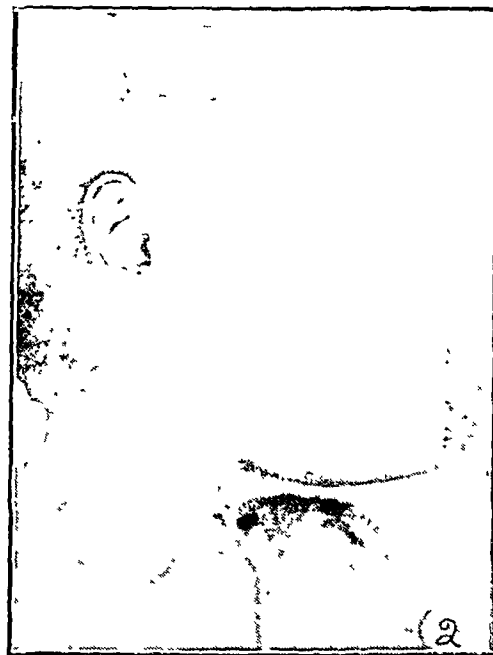


Fig. 2.

A.P. and lateral views of an advanced case of Tumour Maxilla.

as a complication of an already existing pathological condition as for eg. Paget's disease of bone. One hesitates to contradict the findings of such an authoritative pronouncement but some of the cases occurring here do seem to exhibit some differences. Thus, some patients come complaining of the swelling which has attracted their attention and not the pain as a prominent feature. Cases of osteogenic sarcoma have occurred occasionally in the elderly in the absence of any other pathological condition.

3. In cases of benign giant cell tumours, healing of the cavities resulting after curettage, may be hastened by skin-graft. A mould of the cavity is prepared with Stent's wax, skin-graft with the mucous surface out is laid on it, and introduced

ling, though it did not disappear completely, was stationary for about 6 years. Then it began to gradually increase in size and in 3 years reached the condition shown in Fig. 6, and during the last three months was growing rapidly, with local pain as well as headache. It interfered with vision considerably due to its overhanging the eye. The swelling was smooth and globular, had hard bony margins, and there was egg shell crackling in places. Overlying skin was healthy. Regional lymph nodes were not enlarged. The fundi were normal. W.R. was positive strong, but antisyphilitic treatment had no effect on the swelling. 60 c.c. of thick dirty brown material was aspirated through one of the soft spots which showed in the microscope only amorphous material.





Fig. 3.



Fig. 4.

A.P. and lateral skiagrams of the same patient.



Fig. 5.

"Traumatic cyst of skull" (Frontal bone).  
Condition on 19-6-35.

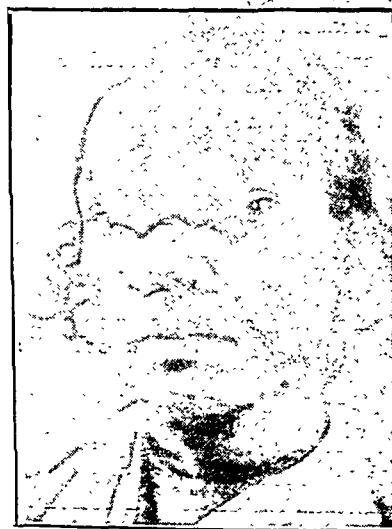


Fig. 6.

Same case as Fig. 5. Condition on 24-4-44.  
(Before operation).

On 8-7-44 the swelling was operated on and the bony wall was removed. The contents were a fair amount of thick dirty brown gelatinous fluid. The posterior wall was very thin in places and as it was feared that this may be the only partition



Fig. 7.

Same case as Figs. 5 & 6. Condition on 27-7-44. (After operation).

between the tumour and the meninges, this was not removed, but the lining of the cyst was carbolicised and washed with spirit. The post-operative course was uneventful except for the necessity for three or four aspirations of collected fluid. Fig. 7 shows condition after operation.

Pathological examination of cyst wall showed a lining of granulation tissue with pseudo-xanthomatous appearance: no evidence of dermoid.

Her general condition improved and vision became perfectly normal.

The above condition fits in best with what the Americans call "traumatic cyst of skull." (Ref.: Surg. Gyaenec & Obst.)\*

Dr. U. Mohan Rau: demonstrated skiagrams of a case of secondary deposits from a carcinoma of the breast. The secondary deposit in the humerus was of the osteolytic variety and the secondary deposit in the skull was of the osteoblastic variety, thereby demonstrating that the same tumour can produce both osteolytic and osteoblastic bony metastasis.

He also showed the X-Rays of a patient with carcinoma of the prostate who had secondary deposits (osteosclerotic) in practically every bone in the body but his lungs were free from secon-

dary deposits, thereby proving Batson's theory of distant metastasis in prostatic carcinoma through the inter-communication between the pelvic plexus of veins on the one hand and the spinal and the other systemic veins on the other hand.

Dr. N. S. Narasimhan: The figures just given out from Tata Memorial Clinic show a very large preponderance of Ewing's tumour. Even allowing for faults in diagnosis, the figure seems high and requires explanation. My own personal series shows 53 bone sarcomas in ten years. Only 4 of these are Ewing's. There were 60 bone biopsies in the Pathology Department of the Madras Medical College in ten years and there were 6 cases of Ewing's tumour. It is accepted that amputation in Osteogenic Sarcomas and Xradiation in Ewings form the standard treatment at present. There is no difference of opinion regarding the ultimate prognosis of these cases. The difference of opinion lies in the early diagnosis and its difficulties. Since the recent War years, one meets with many cases of Pyogenic osteomyelitis of low grade toxicity with good deal of bone pain and biopsy has been essential in correctly diagnosing these cases. In one instance where the radiologist was of opinion that the case was one of sarcoma and too far advanced for radiation, the case happened to be one of Osteomyelitis. Biopsy is essential for jaw tumours since cases of plasmocystoma will be otherwise misdiagnosed and unnecessary operation be undertaken. It happened in one instance in this series. During this ten year period I had 32 cases of giant celled tumour of bone. There were different kinds of treatment during this period. Simple curettage, curettage with swabbing with chemicals as carbolic acid or zinc chloride, excision of bone such as the talus and the lower end of the radius, excision followed by bone graft as in the lower end of the tibia, excision followed by the use of half of the femur (Putti's Operation) were being done. For the past three years, deep Xray therapy was given after any of the procedures to avoid recurrence. It was soon noticed that in 3 cases, the tumour became malignant clinically and histologically, and led to amputations. Just at this period Brailsford published in the Medical Annual similar experiences and advised that the treatment showed be either only radiation or only surgical procedures. After a combined meeting of Radiologists and Surgeons, we in Madras have agreed to adopt this procedure.

Deep XRay radiation does calcify the tumour in its periphery and this can be seen 3 to 6 months after radiation, but the tumour cells in the centre probably escape and after calcification, surgical excision with grafting is required. There were many mistakes in the diagnosis in the early stages of giant celled tumour; the area of loss of density has been mistaken for tuberculosis: one of the cases of giant cell tumour of the lower end of the

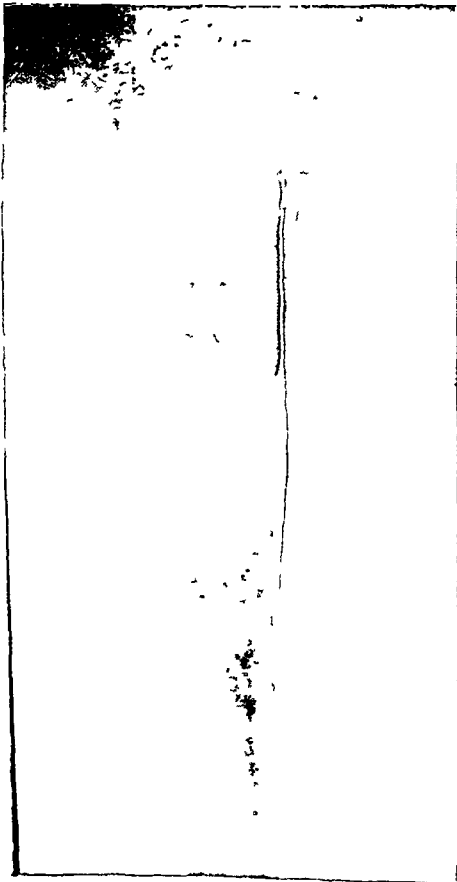
#### REFERENCE\*

"The 1944 Year Book of General Surgery" (Graham, Evarts, A.), pages 223-224.

femur which I mistook for tuberculosis was subsequently admitted into another hospital for Pathological fractures. Giant celled tumour of Talus was mistaken for tubercle. In a series of 63 cases of bone biopsy where giant-celled tumour was diagnosed histologically, there were 23 clinical mistakes. Fullest co-operation of the Pathologist is given and obtained and Ellis' bone biopsy technique is followed. With excised bones even, one part of the tumour showed fibroma and when several sections were taken, it was proved to be telangiectatic Sarcoma.

I have found it extremely difficult to study and understand the reaction of bone to trauma and the histological changes that follow even normal calcification after fractures. A series of normal studies are urgently required so that the students and teachers become familiar with normal microscopic pictures of repair in bone and at what stage that repair process becomes pathological.

*Dr R N Dixit* (1) It is sometimes impossible to diagnose a case of bone tumour, merely by clinical and radiological examination. A biopsy in each and every case of suspected bone-tumour is absolutely necessary. Every case of suspected



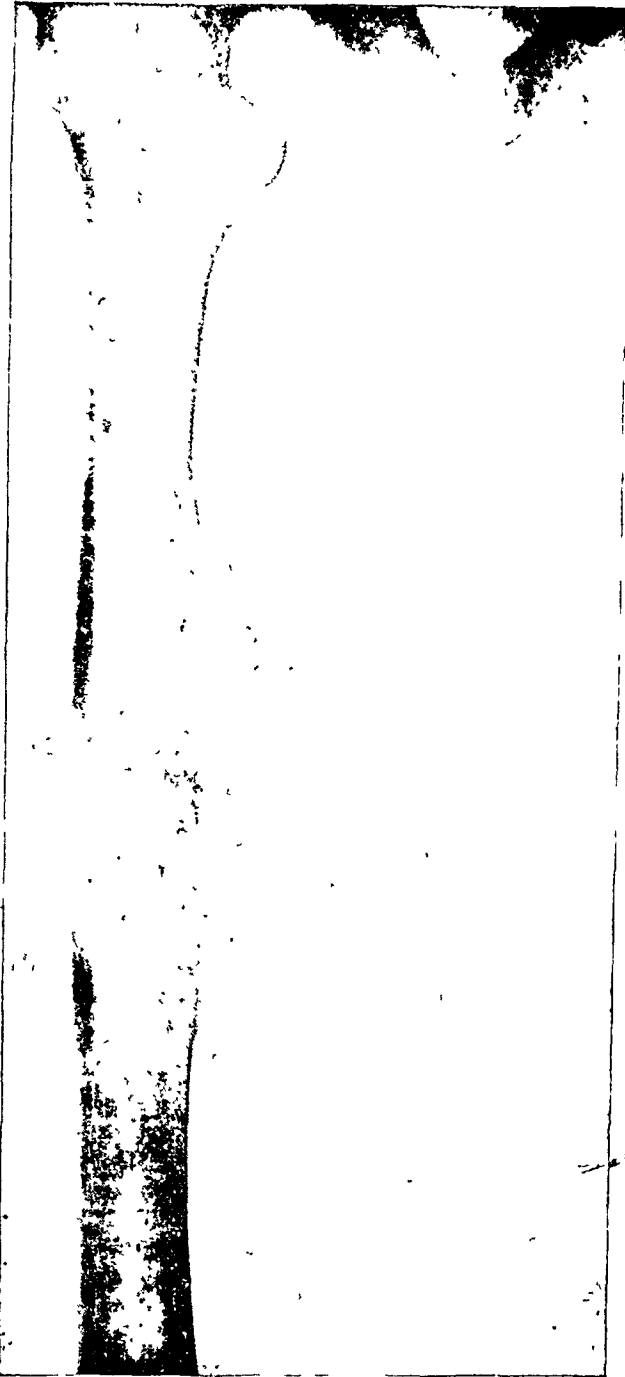


Fig. 3.

—Dixit

bone tumour should be jointly investigated and treated by the surgeon and the radiologist under the guidance of the pathologist. Removal of a piece of tumour for biopsy does not increase the risk of dissemination as is usually feared.

(2) The case report and skiagrams of a case of bone tumour were presented. A young woman

aged 25 years developed pain and swelling of the middle of shaft of femur, following some trivial injury some six weeks ago. From the clinical and radiological appearances one was led to believe it to be an inflammatory lesion. On the operation table however it was proved to be a case of bone-tumour of great vascularity. The biopsy report was not received but the speaker thought it to be a case of Ewing's tumour, which was not as rare as it was thought to be.

Dr. E. J. Borges said that he would like to emphasise some of the statements made by Dr. Meher-Homji. He drew attention to the high incidence of Ewing's tumour in the Tata Memorial Series. One might seek to explain this incidence which is higher than recorded by others by pointing out that bone tumours requiring radiation are more likely to be referred to that hospital than tumours like osteogenic sarcomas which are treated surgically at general hospitals. This, however, cannot be the case as many of the tumours sent as osteogenic sarcomas turned out to be Ewing's tumours. It must be made clear that the diagnosis of Ewing's tumour was made in all the cases by aspiration biopsy (or knife biopsy when necessary) and confirmed by the response to radiation and subsequent history of the patient.

He also wanted to draw special attention to the great importance of a definite histological diagnosis before any treatment was instituted. To illustrate this he presented skiagrams of 3 patients.

The first was of a girl of 9 years who had a lesion of the radius which had all the radiographic features described as being characteristic of Ewing's tumour. She was seen by a competent surgeon elsewhere who diagnosed it as Ewing's tumour. Seen at the Tata Memorial Hospital a clinical diagnosis of Ewing's tumour was made. As a routine an aspiration biopsy was done and a drop of what looked like purulent material was obtained. A microscopical examination revealed inflammatory exudate. She was placed on Penicillin therapy and in 6 weeks the bony tumour had subsided completely. Here was a subacute osteomyelitis which would have passed as Ewing's tumour but for a microscopic examination.

The second case was that of a young man of 20 with a tumour of the upper end of the tibia. The radiographic features were typical of osteogenic sarcoma with the characteristic sun-ray appearance. Aspiration biopsy revealed inflammatory exudate. A knife biopsy was done and confirmed an inflammatory lesion. Penicillin produced an appreciable diminution of the tumour; later the patient was lost sight of.

The third case was that of a young man with a giant cell tumour of the upper end of the tibia. Aspiration biopsy yield no material for a definite diagnosis. A knife biopsy revealed a malignant giant cell tumour. A mid-thigh amputation was done. He developed a local recurrence in the

amputated stump. A disarticulation of the hip was done. This did not prevent the patient dying from metastasis to the lungs.

All these three cases, a few out of the many that could be demonstrated, show that it is unsound to treat a bone tumour without a definite histological diagnosis. At the Tata Memorial Hos-

pital they had learnt that though a clinical diagnosis based on clinical and radiographic features was correct in a large proportion of cases, the percentage of errors in diagnosis based solely on these features was high enough to make it imperative that no bone tumour should be treated without a previous histological diagnosis. Aspiration biopsy was a simple and harmless method of obtaining this.



Fig. 1.

Case No. G 2056. Skiagram showing enlargement of shaft of the radius mainly from periosteal new bone formation in "onion-peel" layers, condensation of original cortex and small areas of bone destruction. Clinical diagnosis: Ewings Tumour. Aspiration biopsy: Inflammatory Tissue Cure with penicillin. (Boiges)

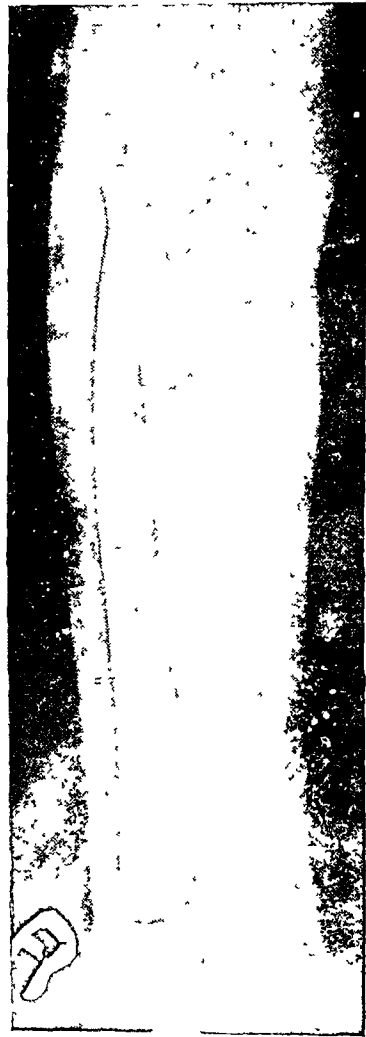


Fig. 2.

Case No. G 2056. Skiagram of same patient as in Fig. 1 taken 3 weeks after penicillin therapy. Regression of swelling, two small cavities in the centre of shaft. Subsequently patient completely cured. (Borges)

Dr. K. C. Nambiar: referred to a case of osteogenic sarcoma of the proximal phalanx of the fourth rt. toe showing the following points of interest:—

(1) History of kick from a cow on the toe one year before the complaint.

(2) Unusual site for osteogenic sarcoma. At this place, a chondroma of short bones becomes malignant into a sarcoma. Here, there is no history of a chondroma.

(3) Recurrence, after a local amputation upto the middle of the metatarsal bone and a full course of deep-x-ray, in 6 months time into the inguinal glands while showing no secondaries in the chest.

(4) After complete removal of the lymphatic glands and another course of x-ray, development of subcutaneous nodules all over the body in hundreds without lung involvement.

(5) Pathological report of Osteogenic Sarcoma from (1) The toe, (2) Inguinal glands, and (3) Subcutaneous nodules.

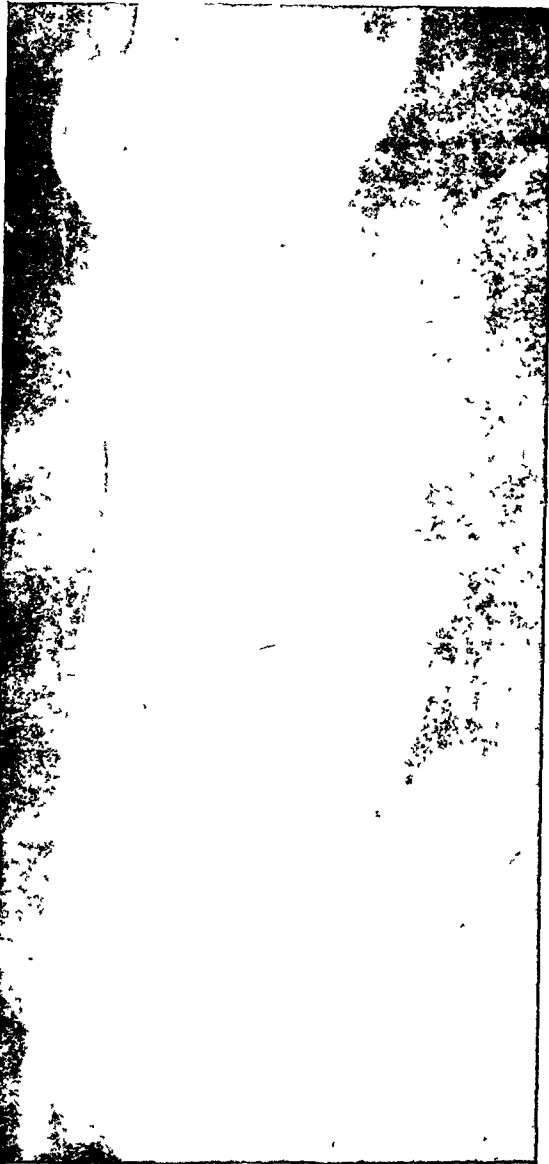


Fig. 3.

Case No. G 2181. Skiagram showing sun-ray appearance of new bone formation described as characteristic of osteogenic sarcoma. Clinical diagnosis: osteogenic sarcoma. Aspiration biopsy: inflammatory tissue. Knife biopsy: inflammatory lesion. Improved considerably with penicillin. (Borges)



Fig. 4.

Case-No. 5343. Skiagram showing a benign giant cell tumour of tibia. The slightly washed away appearance of trabeculae, and irregular broken outline at lower end of tumour, best seen in lateral view, suggests possible malignant nature. Biopsy: Malignant giant cell tumour. (Borges)

This case is of great clinical interest as the above points are variations from the normal.

Dr. Khanolkar remarked that he would particularly like to bring to the notice of the surgeons the method of aspiration biopsy of bone tumours which is employed at the Tata Memorial Hospital for two reasons.

1. The method affords a very useful diagnostic aid to the clinicians, when it is employed in co-operation with a pathologist who has been trained for this type of work. The experience of the Tata Memorial Hospital staff shows that it is probably the most reliable procedure for diagnosis in a difficult group of tumours. The advantages and drawbacks of the method, as well as the technical details have been fully discussed in a recent publication (Khanolkar, V. R., and Nerurkar, R. V.: Indian Physician, 5: 125-135: 1946) and would

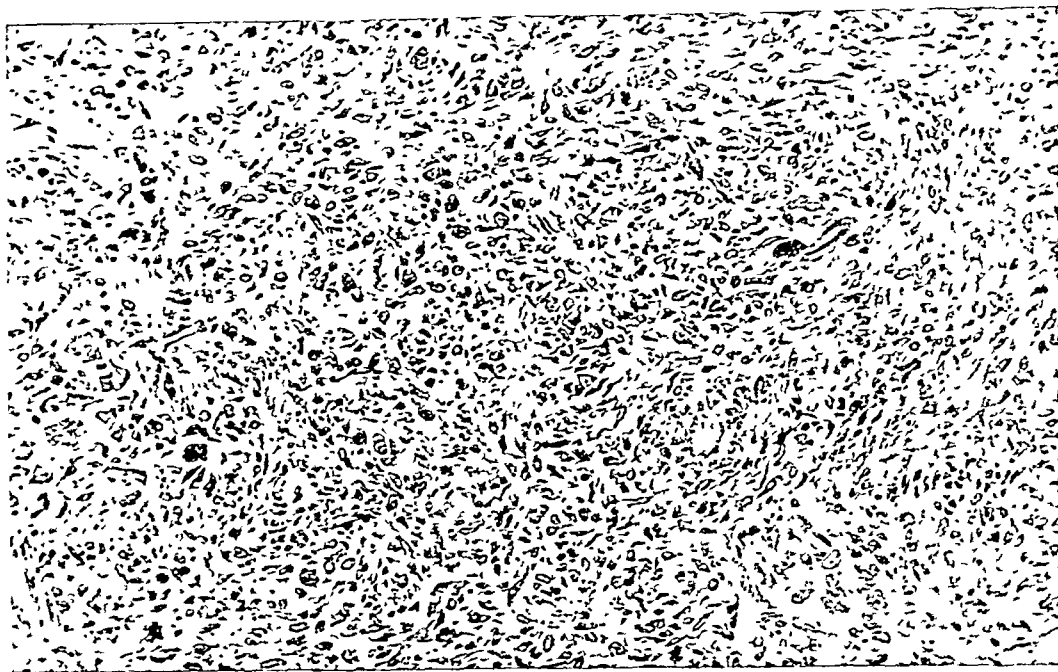


Fig. 5.

Case No. 5343. Microphotograph of tumour described in Fig. 4. It shows that the multinucleated giant cells are few, and widely separated by stroma cells which are fusiform in shape and densely packed. The nuclei of these stroma cells are mostly ovoid and show a marked variation in size: Malignant Giant Cell Tumour. (Borges)

well repay careful perusal by surgeons who may be called upon to deal with bone tumours.

2. The method does not have any of the grave consequences (ulceration, fungation, etc.) which follow an unskilful knife biopsy. The staff of the Tata Memorial Hospital avoid cutting into these tumours, unless repeated aspiration biopsies fail to establish a definite diagnosis. The experience of the past four years does not lend any support to the fear expressed at the meeting, that aspiration biopsy may precipitate a rapid spread of the tumour and considerably aggravate the course of the disease. The observations on experimental animals also do not sustain this belief (Maun, M. E., and Dunning, W. F.: Surg, Gynec. & Obstr. 82: 567-572: 1946).

Dr. V. S. Sheth reported two cases—one of Ewing's tumour in a man of 40, where the Radiological diagnosis was between chronic Osteomyelitis and Ewing's tumour and where biopsy settled the issue, and a girl of 17 was suspected to have a bony tumour. Osteoclastoma in the 4th metacarpal bone, which, on biopsy proved to be tuberculosis.

Dr. K. S. Nigam: laid emphasis on the following points:—

1. Early diagnosis is a *sine qua non* in the management of bone tumours specially the malignant ones.

2. Biopsy is very helpful and if carried out with care (for example using punch or suction biopsy) was devoid of any apprehension of encouraging dissemination or metastases.

3. Radical surgery at a reasonably early stage has in the speakers' experience saved many lives.

Photographs of cases were shown.

Dr. S. J. Mehta agreed that Surgery has to be tackled with the help of the Radiologist and the pathologist if cases are to be treated successfully.

He, however, pointed out that the pathologist also is liable to make a mistake and gave an instance where in a malignant tumour in a boy of 21, biopsy did not show any malignancy.

Dr. D. G. Ojha showed the X-Ray plate of a case of Haemangio-osteoma of the orbital plate of of frontal bone with the description in brief of the clinical findings. He mentioned and stressed characteristic Radiological finding of the radiating spongy pattern as that enables one to diagnose the

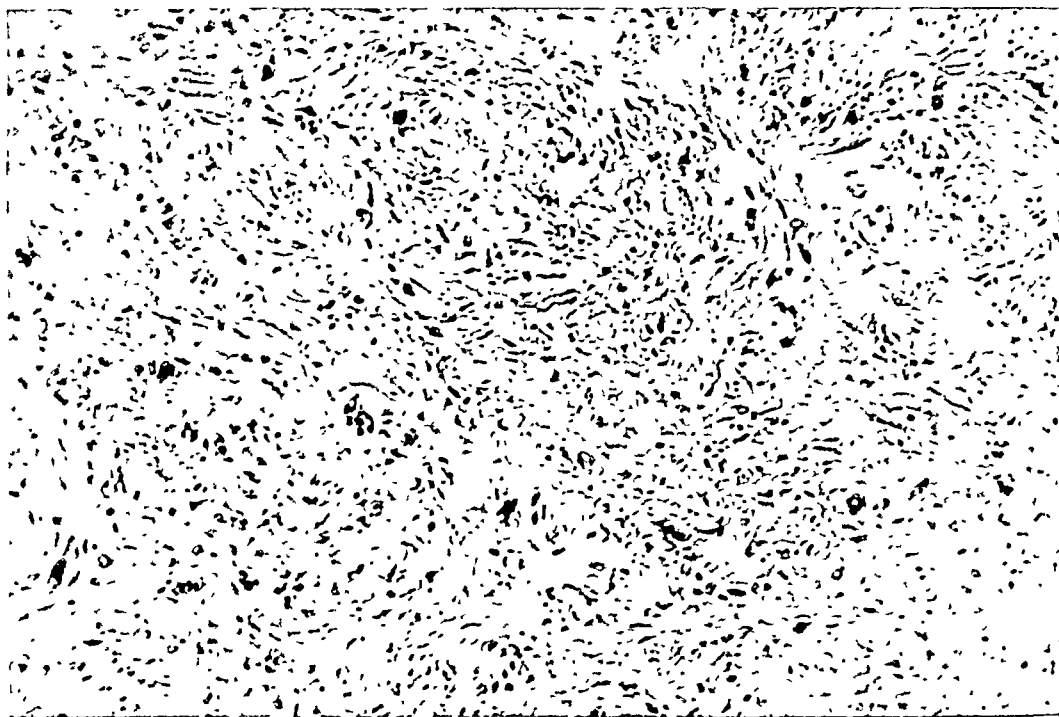


Fig. 6.

Case No. 4537. Microphotograph of Benign Giant Cell Tumour to contrast with Fig 5. It shows numerous multinucleated giant cells separated by sparse stroma cells with ovoid nuclei which are uniform in size. (Borges)

condition preoperatively. The Macroscopic appearance of the tumour is that of the cut surface of a betelnut—the white part corresponding to the bone and the brown part to the angiomatous tissue.

He mentioned that in their series of malignant bone tumours the actual case of Ewing's tumour was only one and the rest were all osteogenic sarcoma. They have had over a dozen malignant tumours during the last few years.

He stressed the possibility of wrong diagnosis of Ewing's tumour by radiological appearances alone as happened in one of their cases which on operation—opening up the medulla—turned out to be an encysted abscess in the mid-shaft of the humerus. The causative organism *Staphylococcus pyogenes* was detected, in the pus.

Further, he requested Dr. Kini to explain why he had done resection and bone grafting in a case of localized fibrocystic disease when a simple procedure like opening up the cystic spaces and curettage would have given equally good results. The condition not being a growth, but rather a developmental defect should have been treated on more conservative lines.

Dr. K. M. Rai: At the Barnard Institute of Radiology, Madras during the last seven years we

have treated 170 cases of bone tumours. Of these Osteosarcoma formed the largest number, this group contributing as much as 62.9%. Ewing's tumour formed 7.1% Plasmocytoma 2.3% Chondro Sarcoma 2.3% and Osteoclastoma 25.4%.

#### DURATION OF COMPLAINT

Among malignant tumours 46.2% reported for treatment before 3 months and 81.4% before 6 months—while among Osteoclastoma the corresponding figures were 18% and 36%.

#### AGE OF INCIDENCE

In the case of malignant tumours the maximum incidence was in the second decade viz. 33.6% and the third decade was next with 29%. In Osteoclastoma the maximum incidence was in the third decade (44.2%), the fourth decade came next (23.2%). Among malignant tumours the minimum age recorded was one and a half years and the maximum age 68 years. In Osteoclastoma no case was seen below 10 years.

#### SEX

In malignant tumours the ratio was as follows:—Males: Females:—2.7 : 1.0. In Osteoclastoma, males: females were as 3.8 : 1.0.



## SITE

In malignant tumours the frequency of incidence was more in the lower limb, this being involved in as much as 48.6%. Next came the upper limb with 19.6%. The most common site in the whole skeleton was the lower end of femur (28%) next in order was upper end of humerus (12%) upper end of tibia (10.30%) pelvis (9.3%) and scapula (7.5%).

In Osteoclastoma the most common site was lower end of femur (20.9%) next came the lower end of the radius (18.6%), lower jaw 13.7% and upper end of tibia 9.3%.

## OSTEOSARCOMA

Regarding age of incidence and site, our findings were in conformity with other workers. Regarding sex our finding is that it is more common in men while the text books put it as more common in women. We had a few cases occurring at rare sites, notable being, lower end of radius (2 cases) metacarpals (2 cases) phalanges of hand (2 cases) and tarsal bone (1 case). The treatment advised in our hospital is amputation. Where this is refused radiation therapy is resorted to. Radiation by itself has proved very disappointing. Most of our cases which we could follow up died within 18 months. Of late, being encouraged by the good results at the Memorial Hospital, New York, of the combined method of radiation and amputation, we have been following this method. We have not had the fortune to follow up all our cases; in one instance, a patient subjected to this method of combined treatment is alive still nearly three years after the onset of the disease. Osteolytic lesions responded better to X-radiation than the sclerotic types.

## EWING SARCOMA

This disease formed 7.1% of the bone tumours in our series. The maximum age incidence was in the second decade and the most common site was in the shaft of the femur. Males preponderated. Our findings are in conformity with Western authorities. Here also the outlook has been gloomy, though the immediate results are encouraging, involvement of other bones, lymph nodes and skin, all these ultimately leading to a fatal end. In our experience, the maximum survival period after commencement of treatment was 2½ years. In one case the tibial shaft was first involved; this was treated and responded well. Later the frontal bone was involved along with wide spread subcutaneous involvement of the endo-thelial tissues. When this occurred, no further treatment was recommended.

## PLASMOCYTOMA

It is in this disease that we had some gratifying results. We followed up one case as long as about 8 years, another case is alive and well, over 2 years since onset. We did not have many cases of this type, the percentage in our series being 2.3%. In the first case referred to above, the lesion originally started in the shaft of the right tibia, later it involved left patella, left femur, left eleventh rib, left humerus, skull at various sites, left maxillary antrum and ethmoid and orbit, and finally the retroperitoneal lymph nodes.

## OSTEOCLASTOMA

These formed 25.4% of our series. The maximum age incidence is third and fourth decades, whereas the Western authorities put it as second and third decades. It is in this group that we had some good results. We use only X-radiation. We do not advocate any combination of this with surgical curetting. The combined treatment which we followed in the beginning of our series gave us disastrous results with the exception of a few, in that the tumour turned malignant after some time. With X-radiation alone nearly 80% of cases have consolidated. The numbers we followed are few and we are still following this method and ere long hope to assess the permanent value of this treatment.

## Reply by Meher Homji

My job of answering the questions has been greatly facilitated, since many of the questions have been answered by my colleagues, Drs. Khanolkar and Borges. To Dr. Chatterji I may state that the regeneration and recalcification process after X-ray therapy of Benign Giant Tumour, is a very slow one, and that it takes sometimes 1½ to 2 years or even more. One must have patience with this type of treatment. Dr. S. J. Mehta asked as to why the combination of surgery and irradiation is not to be recommended. I may answer that this point has already been mentioned in my paper. Answering his other question as to why disarticulation be performed for osteogenic sarcoma of the lower end of femur, the generally accepted procedure of choice is amputation above the proximal joint of the bone affected. However in the cases of tumour involving the lower end of femur, a high thigh amputation has been recommended. Our previous experience has shown us that sometimes when a high thigh amputation is done, there is extension of disease at the site of section of bone and as it is impossible to tell radiographically how far the microscopic extension of disease has reached, it is wiser to perform a disarticulation as the life of the patient is more important than the limb.

## THE PROBLEM OF INFECTION IN BURNS

by P. K. SEN\*

I present today the report on a detailed study of a consecutive series of 160 cases of burns (thermal and from other causes) treated in the K. E. M. Hospital, Bombay, during the years 1944 to 1947. This enquiry was undertaken by the Surgical Society of the Hospital and carried out under its guidance first by Dr. G. M. Phadke and later by myself and the two whole-time research workers, Drs. Ketkar and Jahagirdar, appointed for the purpose.

In undertaking this investigation we have been guided mainly by clinical criteria; biochemical and other laboratory investigations e.g., estimation of blood protein levels, haemoglobin and cultural examinations etc., though carried out in most cases do not form the main background of this work. Since April this year, however, we have attempted a study of the nutrition of burnt patients (a series which is different from the first 160 cases) on which I wish to append notes of a preliminary report at the end of this paper.

The study of the series of 160 cases was largely concerned with the appraisal of the various factors in the production of infection in burns as well as of the methods and agents used in the prophylaxis and treatment of sepsis in the burnt patient. In order to standardise treatment all cases of burns admitted to the hospital during this period were treated by the Burns Unit and the data collected in a special summary sheet (a copy of which is presented here). Since the focus of attention was directed mainly on sepsis and factors operating in its production and control it is best to mention at the outset certain clinical methods and standards used for the purpose of this enquiry. The estimation of area was done

by Berkow's method, according to the schematic chart devised by him and approximately noted in terms of percentage of total body surface. This estimation was made on admission but was not finalised till tissue damage and early sloughing became evident, as it has been our experience that early estimation of area of burn is almost always faulty and some time (often a week or more) has to elapse before the extent of actual damage can be ascertained. The view of the other workers support this (Cope 1944 and Meleney 1945). Sepsis was graded mild, moderate or severe according to whether a purely local reaction, local reaction plus sloughing or local plus marked general reactions were present. The estimation of depth is also subject to the same fallacy as that of area and immediate estimations were not taken as final. In every case of burns there are three zones. One, which is immediately killed by heat and appears as such, one which is injured and rendered non-viable in part but does not appear to be so till some time later and a third which is not injured at all; and until there is an attempt on part of the tissues at slough formation and separation, proper estimation of exact depth is usually difficult. Quite often there is third degree burn under blisters which are stamped as superficial and are only recognised as such on the peeling away of the blistered skin and appearance of granulation tissue which may be quite late. The estimation of depth was done some time after admission with the formation of or even actual separation of slough. In accordance with modern practice depth was estimated as either superficial or deep though the presence of erythema was also noted. For the purpose of this study a superficial burn means one in which the superficial epithelium is injured to the extent of blistering and anything more severe than that short of complete destruction of the deepest epithelial elements in the skin (i.e. in the sweat and

\*K. E. M. Hospital, Bombay. Paper read at the Annual Conference of the Association of Surgeons of India, Dec. 1947.

sebaceous follicles) from which *residual* epithelium restoration can take place. All those areas where epithelial elements are totally destroyed and healing has to take place by the advancing epithelium from the margin or by skin grafts have been categorised as deep. It is obvious that in many cases there have been large areas of superficial burns with small islands of deep burns scattered all over and vice versa and have added to the difficulty of correct estimation of depth and area but as far as possible an attempt was made to obtain reasonably accurate figures. The final results and healing was graded into three categories, viz. (1) Epithelisation without fibrosis or contractures, (2) Epithelisation with fibrosis but little or no contractures and (3) Fibrosis with contractures.

When this study was initiated there existed a great confusion in the minds of surgeons all over the world with regard to the best form of local treatment for burns. The experience of the Massachusetts General Hospital during the treatment of the victims of the Cocoanut Grove disaster (a Boston night club) had first exposed the time honoured practice of debridement to criticism (Cope 1943). Indeed this procedure had become since the advent of the tannic acid treatment by Davidson in 1925, one of the first principles in the treatment of burnt surfaces. Experience gathered from the U. S. Navy during Pearl Harbour and afterwards and subsequent extensive clinical investigations by various workers (Meleny, 1945) served to show that debridement was neither effective nor desirable. In this study no debridement or cleansing of any kind was practised, except in surfaces with very large particles of road dirt, etc., adhering to them, when a gentle saline irrigation was all that was done. Greasy or any other applications used on the area before admission to the hospital was not attempted to be removed.

Burns differ from other wounds in two important respects: (1) They are usually extensive but not deep while other wounds

are usually relatively deep and not as extensive and (2) Surgical procedures aiming at removal of dead and dying tissue with the object of removing contamination and thus reducing sepsis is neither possible nor advisable as with other wounds. It is now clear that all classes of burns no matter from whatever cause, should be regarded as contaminated and potentially infected because the contamination in a burnt area comes not only from external agents but is resident in the depths of the skin itself, in itself, in its deeper layers, i.e. the hair follicles and sweat and sebaceous glands. Secondary contamination does occur as with other wounds and may play a part in the ultimate production of sepsis but is not as important. Under the circumstances forcible scrubbing and cleaning (as during debridement under anaesthesia) will serve not only to kill more tissue, particularly that partially injured by the agent, i.e. not yet dead but which may have survived if not debrided but also to drive contaminating organisms deep into the skin. The blister fluid which has been thought to be an excellent culture medium for the bacterial growth has been shown to be inimical to many pathogenic bacteria due to action of skin lipoids (Burtenshaw 1938, Jamieson 1939). The removal of the blister usually leads to the formation of a fibrin film over the burnt area which is a much better culture medium than blister fluid rich in cholesterol and other tissue lipoids. The obvious advantages of non-debridement—such as avoidance of anaesthesia or adding to the shock by surgical handling need not be enumerated here. Probably very deep burns, i.e. involving muscles and bones with charring, if localised, are the only cases to which the principle of surgical debridement can be rightly applied, and with advantage. Such cases are rare and we have not one such in the present series.

The problem of the burnt patient can be divided into certain phases all of which are not always equally manifest or clearly demarcated from the other. They are in the main five, Shock, toxæmia and nitro-

gen imbalance, infection, slough separation and repair (Meleney). During the progress of a burns case these different phases reach peaks of importance more or less in the same order, sometimes variously and often overlapping considerably. Each phase has an important part to play in the genesis of the next or succeeding ones. The problem of infection (always a serious one) which is comparatively a later manifestation is therefore seen to be closely bound with the earlier phases and factors involved in their production. One of the objects of this paper is to correlate some of these factors with the occurrence, prevention and control of sepsis by means of clinical, biochemical or statistical and other data, as well as to correlate infection and the various factors concerned in its genesis with the later phases of burns and ultimate results, i.e. mortality and healing. The role of the various factors concerned in sepsis, healing and mortality have been considered both generally and statistically in this paper and an effort has been made to correlate both.

The factors themselves are myriad but a number immediately resolve themselves as being more important. By itself probably no single factor determines the onset or nature of sepsis and many causes contribute in varying measure as will be seen in the following graphical and statistical analysis of the more important factors in the production of sepsis in this present series of 160 cases. These are considered in order of their probable importance.

**Depth :—**According to Meleney (1945) this is the most important single factor in the incidence of infection. The relationship of sepsis to depth is shown in Chart I and bears out that sepsis bears a direct relationship to the degree of burn. The mortality figures are also in keeping with it.

**Area :—**A study of Chart 2 shows an equally direct relationship of sepsis to area; the highest peak of infection being in the '10—20%' group. Burns involving larger areas naturally tend to die of shock and pro-

tein loss before sepsis has had time to develop and the incidence of sepsis rapidly falls in larger areas groups. The relationship of area to shock production is seen in Chart 15. Mortality figures are also appended. Chart II(a) shows the relation of blood protein levels to area.

**Contamination :—**Chart 3 of this series shows that the incidence of sepsis is much higher in the so-called clean cases (53%) than in the contaminated ones (38%). This paradoxical finding is in consonance with the opinion of other workers (Cope 1943, Meleney 1945) and serves to show that the surgical principles of wound treatment cannot be applied to burns as to other soft tissue wounds. Every case of burn whether clean or dirty has to be accepted as contaminated in the strict sense. The development of infection is inherent in the very nature of the burn injury as the main bacterial contamination comes from within the burnt skin and not so much from extraneous sources.

**Duration :—**The interval of time that elapses between the accident and hospitalization and treatment is of paramount importance in most wounds, e.g. compound fractures, and the question of debridement is closely associated with this time interval. In studying Chart 4 showing the relation of sepsis to the time interval, though one notices a gradual increase in the incidence of sepsis with later admissions, the rise is neither considerable nor significant. In fact it is somewhat erratic and tends to fall in the '12—24 hour' group after having risen in the earlier series. While the '24 hour and later' group shows a rise again, this is probably due to the introduction of secondary contamination in the later duration groups and is therefore irregular. This, to some extent supports what has already been said about the rationale of early debridement or debridement itself which appears to be of doubtful nature when applied to the treatment of burnt surfaces.

**Site :—**(Chart 5):—Certain sites appear to invariably get infected, e.g. perineum,

back and chest. The 100% incidence of infection in perineal burns needs no explanation and is to be expected no matter what prophylactic measures are used. But infection in areas of the back and chest (very high in the present series) can be prevented by use of sterilised bedsheets, cover etc., and frequent changes of these as also frequent changing of the patients etc. Unfortunately this was not possible in most cases, as this entails constant and diligent individual nursing supervision as is not obtainable in a general hospital. Incidentally it may be noticed that the trunk area burns have the lowest incidence and the largest mortality.

**Agent (Chart 6):**—A study of this factor throws an interesting sidelight on the question of infection in burns. All other factors being equal, probably depth alone determines the onset of infection; and in Chart 6 which sets out the relationship between the agent causing the burn and infection, this fact is borne out. The incidence of sepsis in flame burns is much greater than scalds though their incidence is nearly equal. This is obviously due to greater penetrating effects of flame and consequent greater and deeper tissue damage. Those sustained by burning petrol have the highest sepsis incidence; explained by the greater heat and longer contact with flame. Electric burns (usually deep) are notorious for tissue damage and slow healing; they also not unnaturally are more prone to infection.

**Factors in treatment:—Debridement.** In this connection a comparison of the figures obtained from the study of another consecutive series of 120 cases treated in the same hospital with those of the present series is illuminating. The figures are quoted below. (Table I.)

TABLE I

Incidence of sepsis (total). Debrided cases—48.3%.

Incidence of sepsis (total). Non-debrided cases—36.8%.

Incidence of mortality (total). Debrided cases—18%.

Incidence of mortality (total). Non-debrided cases—15%.

Average healing time. 22.6 days in debrided cases.

Average healing time: 15.4 days in non-debrided cases.

Earlier in this paper the reasons for the non-suitability of debridement as one of the cardinal principles of burn treatment have been enumerated. These figures are in accord with such a view. Even assuming that in the two series different factors may have operated in the ultimate incidence of sepsis it has to be at least conceded that debridement had done no positive good if not any actual harm.

**Local Application:—**In the main two types of agents are usually used in the local treatment of burns; tanning agents with or without antiseptics or chemotherapeutic drugs (e.g. tannic acid, silver nitrate) and emollients such as petroleum jelly, various ointments with vaseline, codliver oil or gelatin base, again with or without antiseptic or chemotherapeutic drugs. Other agents such as electrolytic chlorine, chlorophyll etc., are either for special types or sites or still in the experimental stage. It is not the purpose of this paper to evaluate the merits of the various agents of local therapy and since the use of tanning agents entails the removal of blisters and a certain form of cleansing before the tanning agent is applied, only oily or gelatin based emollients were used directly applied without debridement. A compression bandage was employed wherever possible but again as the proper application of pressurized dressings required constant expert nursing supervision and adequate supplies of elastic stockinet type bandages—both of which were lacking, this part of local treatment was not satisfactory. Three local agents were used; sterile vaseline (Petroleum Jelly), Propamidine Jelly (May & Sulphanilamide 10% emulsion in

oil. The incidence of sepsis with different local agents is shown in Chart No. 7; also vide Tables II & III. The lowest incidence was with the use of local sulphanilamide.

tion while general exhibition of sulpha does not. That the beneficial effect of sulpha in this series is mainly local and not dependant on general absorption from the burnt sur-

TABLE II  
Comparison of Sulpha & Non-Sulpha treated cases and control in Sup. and Deep Burns.

		Superficial					Deep				
		No. of cases	Percent Infection				No. of cases	Percent Infection			
			Mild.	Mod.	Severe	Total		Mild.	Mod.	Severe	Total
No Sulphanamide	...	19	16	16	0	32	36	0	36	11	47
Sulphanamide	...	66	9	10.5	16.5	36	39	12.7	17.7	20.0	50.4
Only general	...	13	15	22	30	67	13	15	15	15	45
Only local	...	50	8	8	12	28	25	12	20	24	56
Local & General	...	3	0	0	33	33	1	0	0	0	0

Sulpha treated cases 2.86% mortality.

Non-drug treated cases 5.5% mortality.

TABLE III  
Percentage of infection associated with different forms of local treatment in non-drug treated burns.

		No. of cases	Superficial				No. of cases	Deep			
			Percent Infection					Percent Infection			
			Mild.	Mod.	Severe	Total		Mild.	Mod.	Severe	Total
Vaseline	...	7	14	0	0	14	5	0	0	60	60
Propamidine	...	17	18	18	6	42	27	8	48	16	67

The composition of sulpha ointment used was as follows:—

Sulphanilamide	12 parts (about 10%)
Calcium oleate	2 "
Beeswax	3 "
Codliver oil	60 "
Water	40 "

Propamidine, one of diamidine group of chemotherapeutic drugs recommended because of its low toxicity from surface absorption, has a lower incidence of infection than vaseline, but the figures for vaseline are probably not statistically significant, the number of cases in that group being small. Propamidine jelly was mainly employed in this series as a control against local sulpha-therapy instead of sterile vaseline, which was discontinued early during this inquiry. According to Meleny's (1945) exhaustive enquiry the use of local sulpha appreciably reduced the incidence of infec-

face is shown in Chart 7 (a). The estimations of blood sulpha level was done in 29 cases while local sulpha alone was used and in most 2 or 3 estimations were done at 2 or 3 day intervals. Average figures of these estimations have been used in the making of the Chart 7 (a). The absorption is shown to be erratic but bears some relation to the area of burn. The levels are quite low—not enough for general therapeutic effect but the highest recorded level (only 1 case) was 16 mgms. No cases of sulpha-poisoning were recorded. Evans & James (1945) carried out experiments which indicate that toxic absorption of sulphonamides from oil base ointments is rare. Toxic blood levels are commoner when water dispersible bases or direct application of sulpha crystals was employed.

*Chemotherapy*:—When this enquiry was initiated penicillin was not available freely—as such only sulpha-drugs have been used

Chart 1.

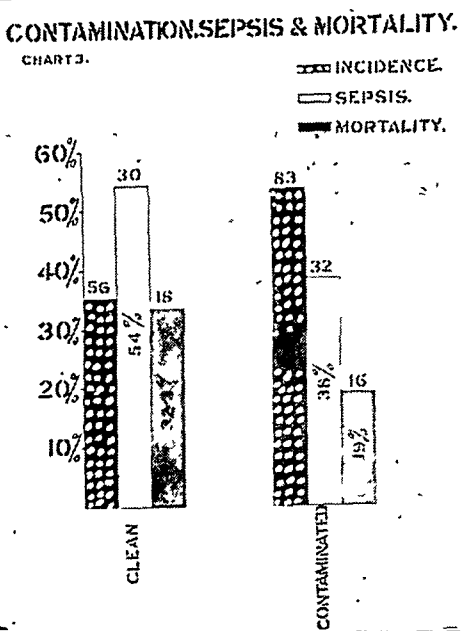
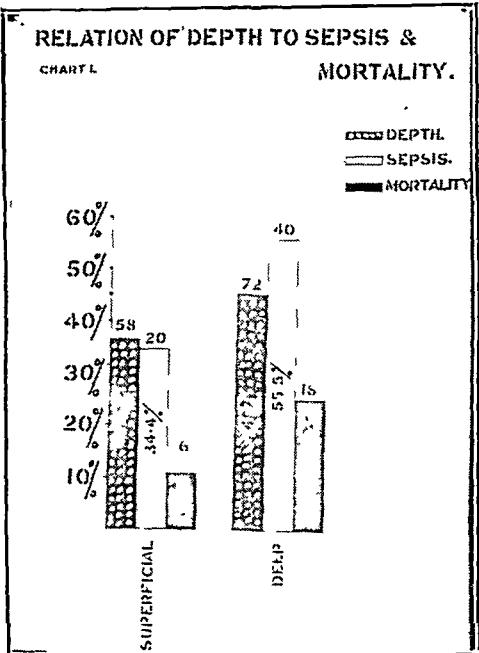


Chart 3.

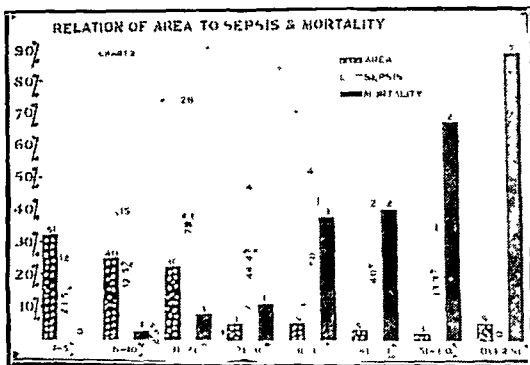


Chart 2.

Chart 2-a.

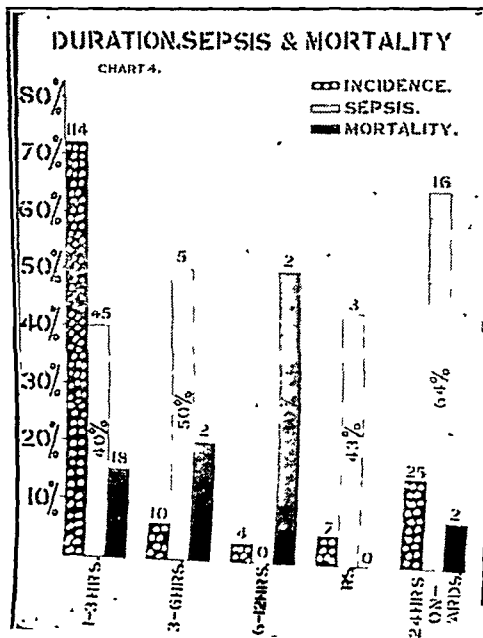
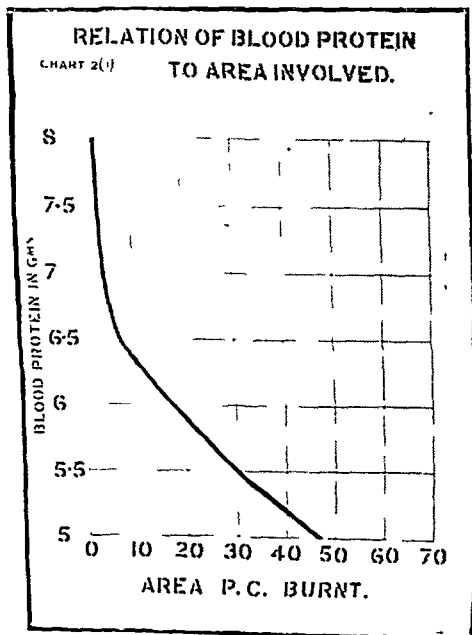


Chart 4.

Chart 5.

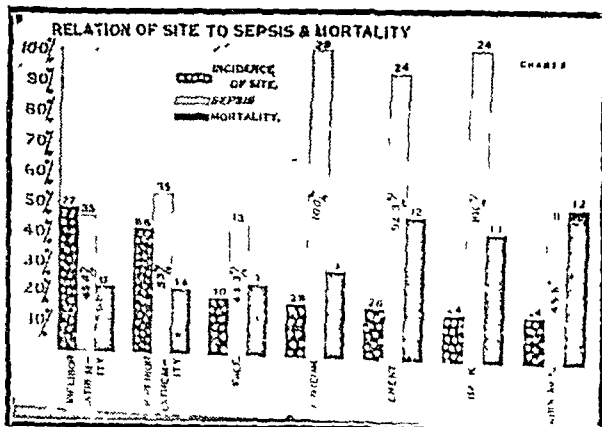


Chart 7.

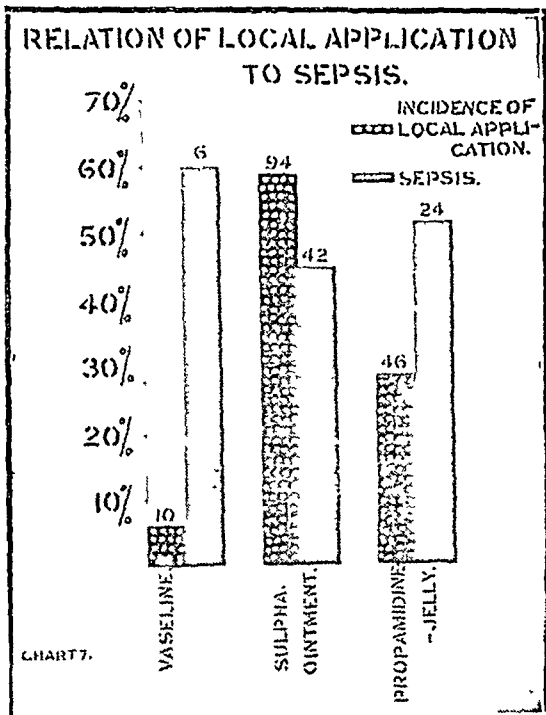


Chart 7-b.

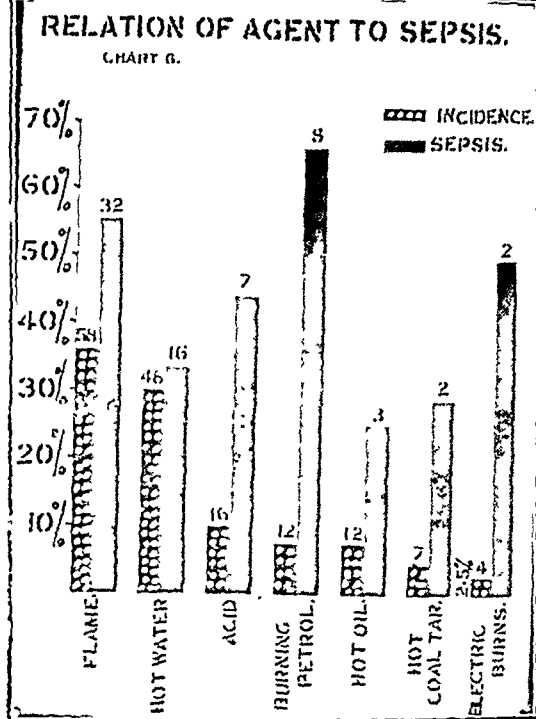
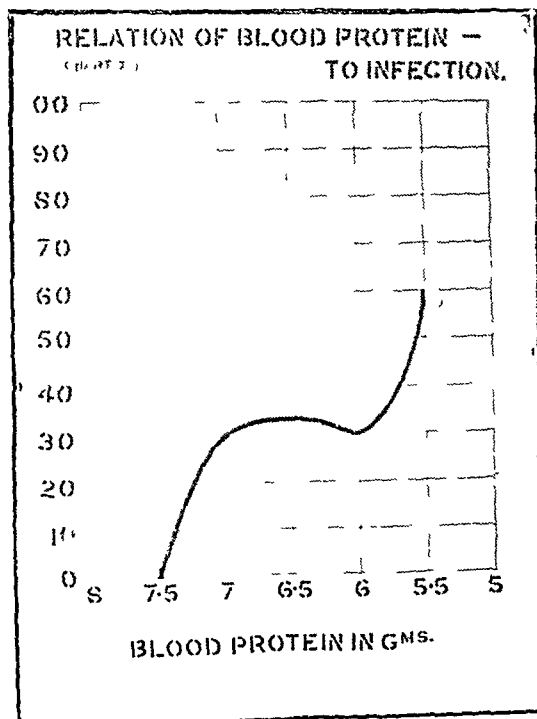


Chart 6.

Chart 7-a.

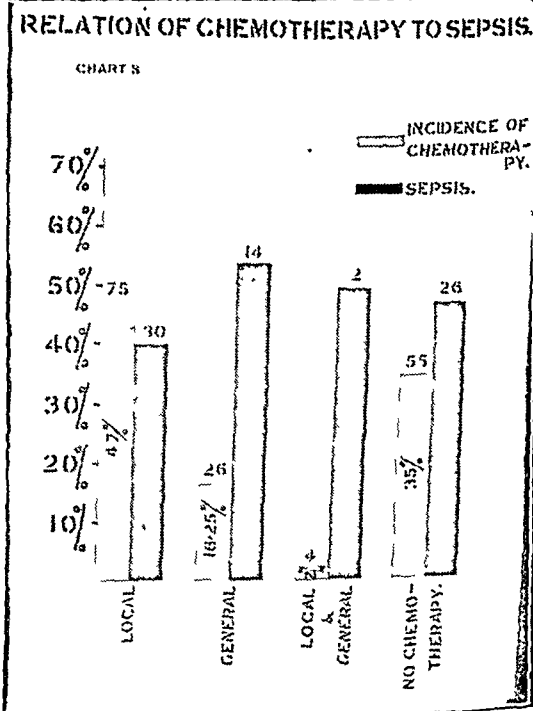
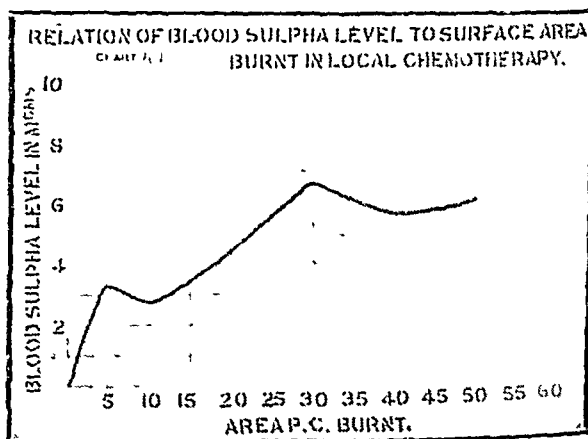


Chart 8.



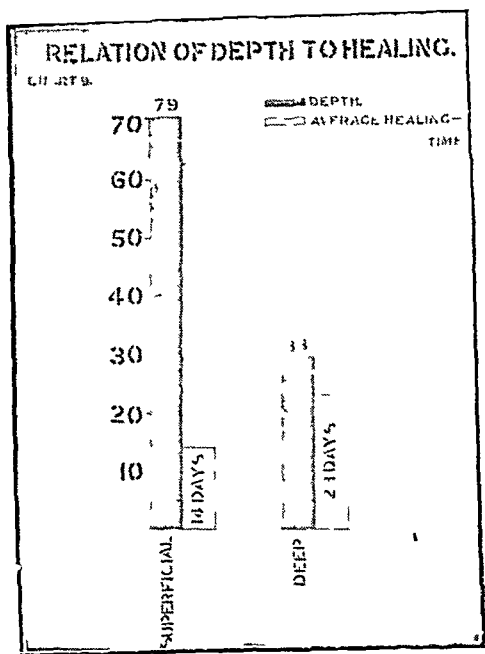


Chart 9

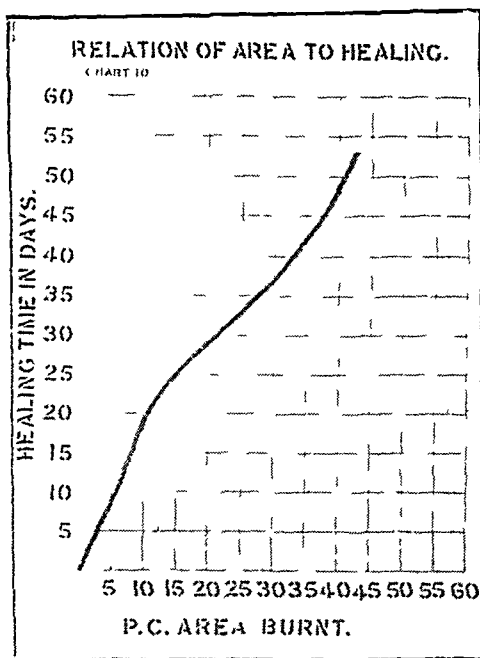


Chart 10.

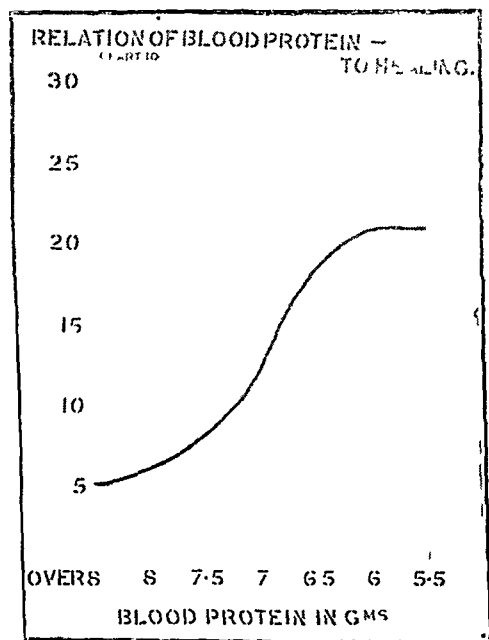


Chart 10-a

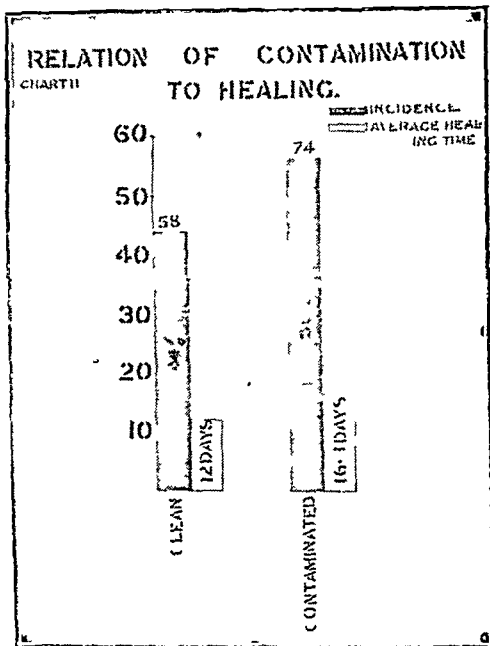


Chart 11

Chart 12.

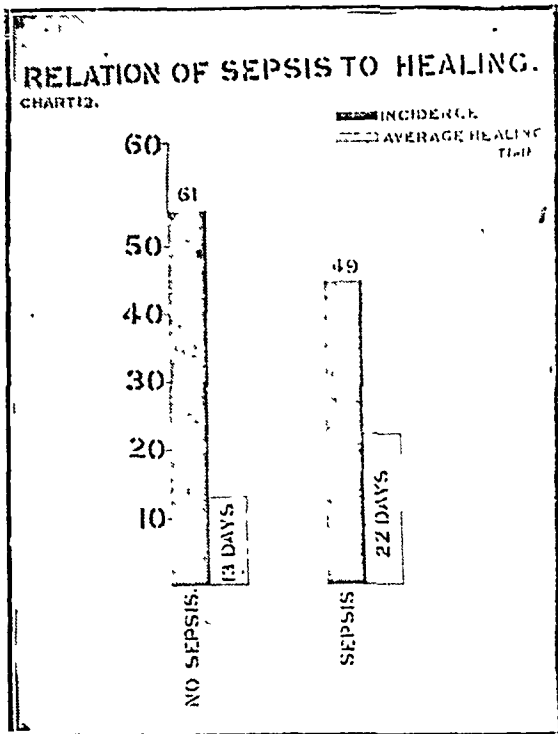


Chart 13.

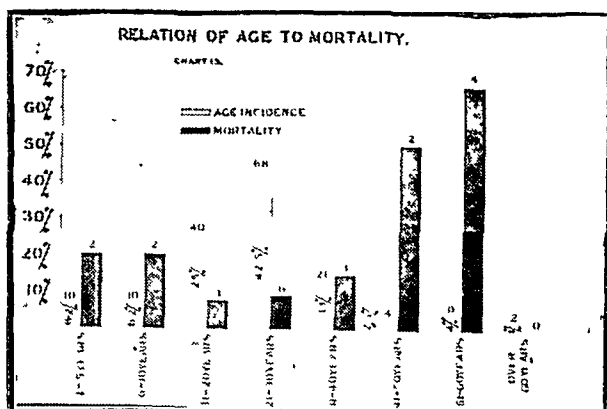


Chart 14.

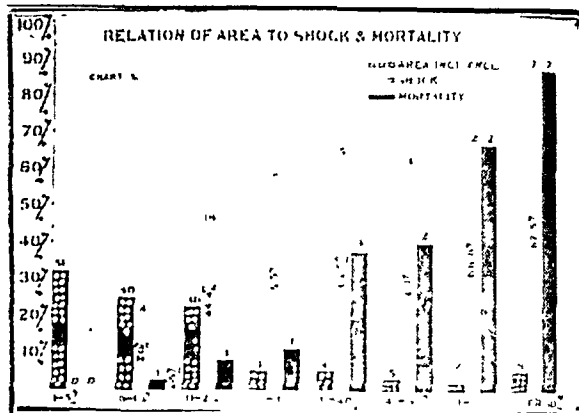
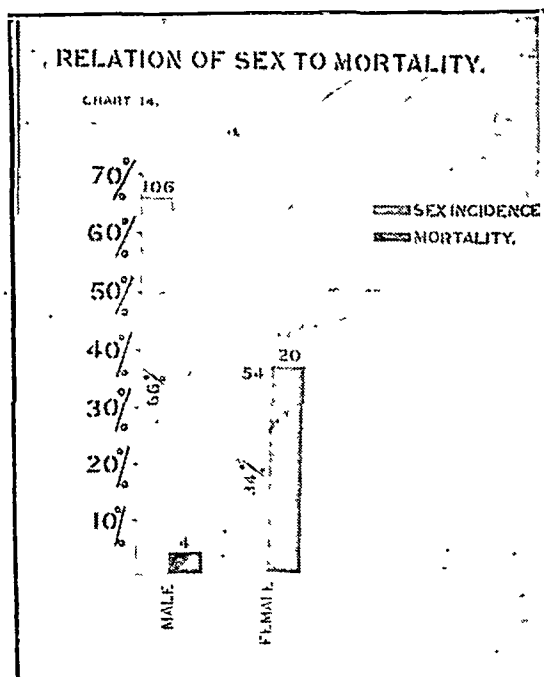


Chart 15.

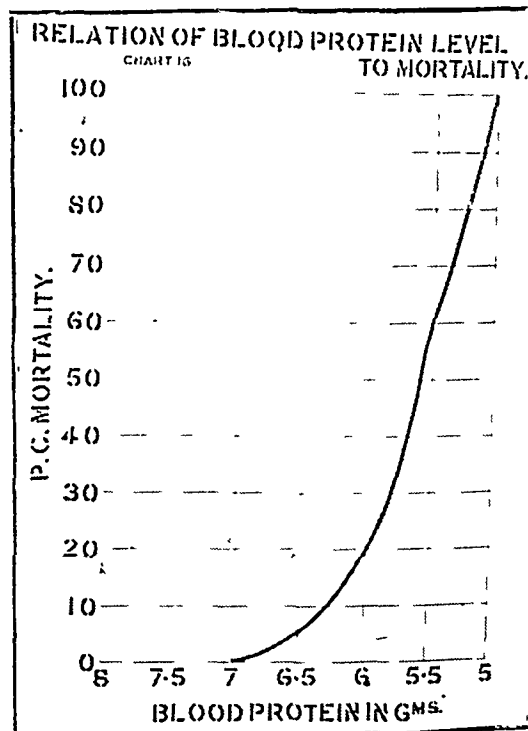


Chart 16.

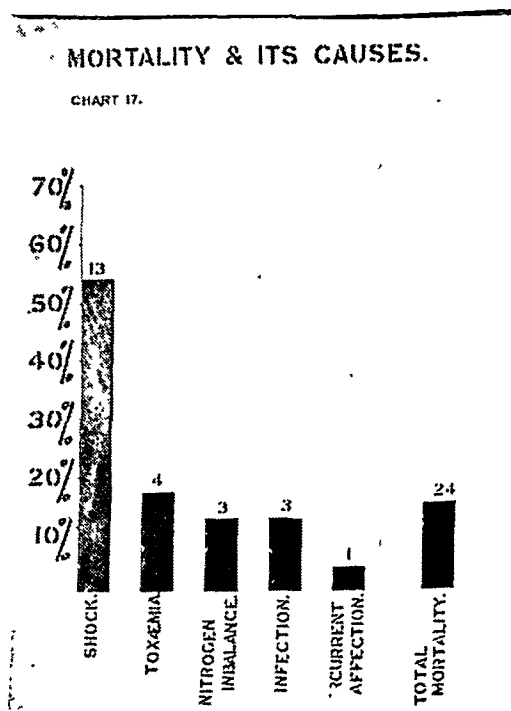


Chart 17.

*Biological Factors*

in the series. The analysis of the effect of such chemotherapy in preventing or controlling sepsis are set out in Chart 8 and Tables II and IV. In determining both the

*Bacteriology*:—Swab cultures from the burn surface were made in more than a third of the series—the more serious being

TABLE IV

Time of onset of infection as correlated with the use or non-use of sulfa treatment.

		No. of cases	Percent incidence	Percent of Infection			16 days onwards
				5 days or less	6-10 days	11-15 days	
Control cases							
Total	...	26		62	31	7	0
Mild	...	4	15.4	75	25	0	0
Moderate	...	18	69.2	55.5	33.3	11.2	0
Severe	...	4	15.4	75	25	0	0
Sulpha treated cases							
Total	...	46		41	50	4.5	4.5
Mild	...	10	21.6	60	30	10	0
Moderate	...	16	34.8	19	73	8	0
Severe	...	20	43.6	50	40	0	10
Control & Sulpha treated cases							
Total	...	72		48.4	43	5.6	2.8
Mild	...	14	19.4	64	29	7	0
Moderate	...	34	47.3	38	53	9	0
Severe	...	24	33.3	53	36	0	11

incidence and time of onset of infection the use of sulpha-drugs seem to have played very little part. Only the local use of sulpha shows a somewhat significantly low incidence figures of sepsis (Table II). The use of general sulpha alone is attended with a very high incidence of sepsis while general + local sulpha has had no better effects though this group is too small to be statistically significant. There is no definite indication from this analysis that infection in sulphonamide treated cases was either prevented, delayed or even less serious than in the non-drug treated cases. The case for the use of local sulphanamide however has been made out. These findings are in complete accord with those of Meleny (1945) in his analysis of 591 cases. But in spite of the apparently questionable value of sulphanamides in the prevention of local sepsis there were only 3 deaths from sepsis in the sulpha treated, 105 cases—a mortality of 2.86% as opposed to 5.5% mortality from sepsis in the non-sulpha treated group. This fact is also noted by Meleny.

chosen for this purpose. Anaerobic cultures were not done. In general, swab culture from a surface is inadequate and even cultures of whole dead tissue removed cannot reveal with any certainty all the organisms in a given case. But the results even with these limitations are interesting and are appended in Table VI.

*Blood Protein Studies*:—It is now becoming increasingly clear in the light of modern research by Cotui and others, that plasma protein loss through and into the burnt area and attendant nitrogen imbalance determine to a great extent the development of late toxæmia in burns. This 'white haemorrhage' as it is called leads to hypoproteinaemia and in its turn to poor fibroblastic reaction and slow healing in which a vitaminosis, particularly deficiency of vitamin C also plays a part. The relation of blood protein levels to healing and mortality in this series are shown in Charts 10 (a) and 16 is at once apparent.

While the part played by protein loss and nitrogen imbalance has been clearly esta-

TABLE V  
Major factors in the incidence of infection following burns (Summarised).

		Percent Infection				Total %
		Totals	Mild	Moderate	Severe	
Superficial & Deep	...	130	7	20	20	47
Superficial only	...	58	8.7	13.9	12.2	34.8
Contamination	...	104	10.7	15.6	14.8	41.1
Clean	...	56	9	25	19.8	53.8
Area over 10%	...	69	10	23	28.6	61.6
Area less than 10%	...	91	11	14.5	4.5	30
Shock	...	52	15.4	23	29	67.4
No shock	...	108	11	7	4	22
No Sulfa	...	19	16	16	0	32
Sulfa	...	66	9	10.5	16.5	36

TABLE VI  
Bacteriological Studies

Organism	Primary culture	No. of cases of sepsis	Subsequent culture. New organisms
St. albus	...	45	20
St. aureus	..	35	21
Diphtheroid	...	7	5
B. subtilis	...	3	2
Gram positive bacilli	...	1	1
Streptococci	...	1	1
B. pyocyaneus	...	0	0
Gram negative bacilli	...	0	0

blished in relation to healing and mortality in burns the same cannot be said of the relation between blood protein levels and development of infection. In Chart 7 (b) such an attempt has been made. The total number of cases in the series 29, is too small for this to be statistically significant, but it is interesting to note, for what it is worth, that the incidence of sepsis rises steeply as blood protein level falls below 6 grams per cent. This roughly tallies with the protein level mortality chart (No. 16).

The major factors in the incidence of infections have been summarised in Table V. Permutations of all the factors would have been impossible and only those of direct import have been included.

*Healing*.—Almost all the factors concerned in the production of sepsis are some directly, and some indirectly, concerned with healing. For the purpose of correlation, the influence of these factors on healing as measured by average healing time

have been set out in Charts 9, 10, 10 (a), 11 and 12.

The final results have been graded as under in Table VII:—

TABLE VII

Grade I (complete epithelisation, no contractures) — 117 cases — sepsis 50; mild 17; moderate 22 & severe 11.

rate contractures)—2 cases—sepsis 20; both moderate.

Grade III (Fibrosis and severe contracture)—1 case—1 sepsis severe.

*Mortality*.—Charts 13, 14, 15, 16 show the relationship of certain factors to mortality not considered so far. The high death rate amongst females is significant and is probably explained by the type of accident and the larger area of burns sustained by women (e.g. sigree and stove accidents, sari catching fire, suicides, etc.). In Chart 17

are summarised the immediate mortality factors. Shock accounts for a larger group (more than half) of the fatalities while infection was responsible for about an eighth of the total mortality. The problem of shock and its treatment is not within the purview of the present paper though one feels that with more energetic treatment this preventable factor in mortality could be considerably minimised.

Toxaemia and nitrogen imbalance (which are closely inter-related and should be considered together) was responsible for nearly 30% of the total deaths in this series. Not much attention has been paid to this factor in the treatment of burns till comparatively recently when Co Tui and his co-workers (1944) first drew serious attention to the nutritional aspect of burn therapy. Davidson as early as 1926 had noted a very marked rise in nitrogen excretion in burnt patients. Lucido (1940) Taylor and others (1943) showed an excretion of as much as 45 gm. of nitrogen in 24 hours in burns of about 40% of body surface. Such loss if continued soon leads to a serious degree of

hypoproteinaemia with all its attendant ills. Restoration of the nitrogen loss has been attempted in three ways—high protein diet, plasma or serum transfusion and administration of predigested proteins by mouth or by the vein. During the last six months attempts at a more detailed study has been made by us into this—the nutritional aspect of the burn problem. Only selected cases (between 10 and 60% of burnt areas) being used for this study. The work is still in its initial stages and so far only seven cases have been studied in detail. Most burn patients have neither the appetite nor digestive capacity for high protein diets and so intravenous plasma and oral case in (enzyme) hydrolysates have been used to restore blood protein values. A cheap variant instead of the costly hydrolysates is skimmed milk powder which has been used with advantage in a few cases. Larger amounts of skim milk powder however have a tendency to produce diarrhoea, but the rise in blood protein has been encouraging. We hope to pursue this line of work further.

# BURNS\*

by MUNAWAR ALI.

## GENERAL TREATMENT OF THE PATIENT WITH SEVERE THERMAL BURN

### Introduction

Effective and yet simple treatment of burns is a problem of considerable value to most of the Surgeons in this sub-continent where facilities for elaborate treatment are not always available. In recent years many valuable contributions have been made to our knowledge of the Pathology and treatment of burns by numerous contributors. The purpose of this communication is to present some of the observations based on the clinical study of 347 cases of severe burns mainly treated at the Osmania Hospital, Hyderabad, Deccan. In this paper I have dealt with the common thermal variety of burns.

Various aspects of the problem of burns are discussed briefly and the practical question of treatment both early and late is presented in some detail. During the past few years as I became more and more interested in the early treatment of burn cases I must confess I became more and more conscious of my ignorance of the vast and varied problems of altered physiology, disturbed bio-chemical phenomena and a host of other things. The late treatment of burn cases with its vast problem of repair of ghastly and crippling deformities so commonly met with in this country attracted my attention considerably. A clear understanding of the physiological, bio-chemical and pathological features is the fundamental requirement for the intelligent treatment of burn cases.

Perhaps it is worth while to recapitulate the important physiological properties of the skin—the structure that bears the great brunt of the accident in burn cases. Skin is the most important protective organ covering the body, it is a barrier to the entrance of bacteria from the surface, it

exerts a strong, firm and elastic pressure of about 10 to 20 millimetres of mercury over the underlying structures, and it plays a vital part in the heat regulation of the body. The fluid secretion of the sweat glands is about 1½ pints a day. Secretions of the sebaceous glands provide an oily coating to the skin.

### Pathology

*Local:* There is great tissue destruction by the causal agent at the time of the accident. Thermal bombardment of the tissue may stop completely after a short time of 30 to 40 seconds, yet a regular chain of processes may extend over hours or days, liberating substances from the damaged cells which are responsible for local oedema and leucocytic infiltration of the region. This autolysis goes on and the process is severe and prolonged in the presence of infection. Thus it is evident that the presence of infection can easily convert a comparatively slight damage into a serious one when burned tissues break down and liquify and flood the body with toxins.

From the damaged and broken skin some serum weeps out, but enormous quantities of plasma are lost from the circulation into subjacent tissues—underneath the burned area—and some around the burn. There is not much evidence to show that there is any appreciable loss of plasma in areas of the body distant from the burn. The most striking feature of a burn is the intense local oedema which sets in very rapidly in less than an hour or two.

It has been demonstrated by numerous workers that this effusion is plasma, except in deep burns where the loss may include blood as well.

If this plasma fluid in, around, and underneath the burn is not returned to the circulation (this can be done to some extent by

\*A paper read at the Annual Conference of the Association of Surgeons of India, Dec. 1947.

early elastic pressure bandaging) it will settle down and coagulate. This may become one of the important factors responsible for the production of excessive fibrous tissue during the healing stage.

*General Pathologic Physiology:* Every severely burnt patient passes through the following phases of disturbed physiological conditions:—

1. *Primary Shock (Neurogenic Shock):* May be absent in severe cases. This is perhaps to a great extent due to associated psychological trauma from fear and anxiety, as it was not much in evidence in service cases during war. Relief of pain by

This phase is instantaneous, transitory and of little clinical importance. Now the patient becomes calm and restful, with full bounding pulse and quiet respiration. This may deceive one from the dangers yet to come. The primary shock accounts for about 2 per cent of the fatalities.

2. *Secondary Shock (Burn Shock or Vasogenic Shock):* This may be expected to develop, if the burn involves 5 to 8 per cent of body surface in children and 12 to 15 per cent in adults, and if not prevented. Symptoms of burn shock become apparent when blood pressure falls to 80 mm. hg.;

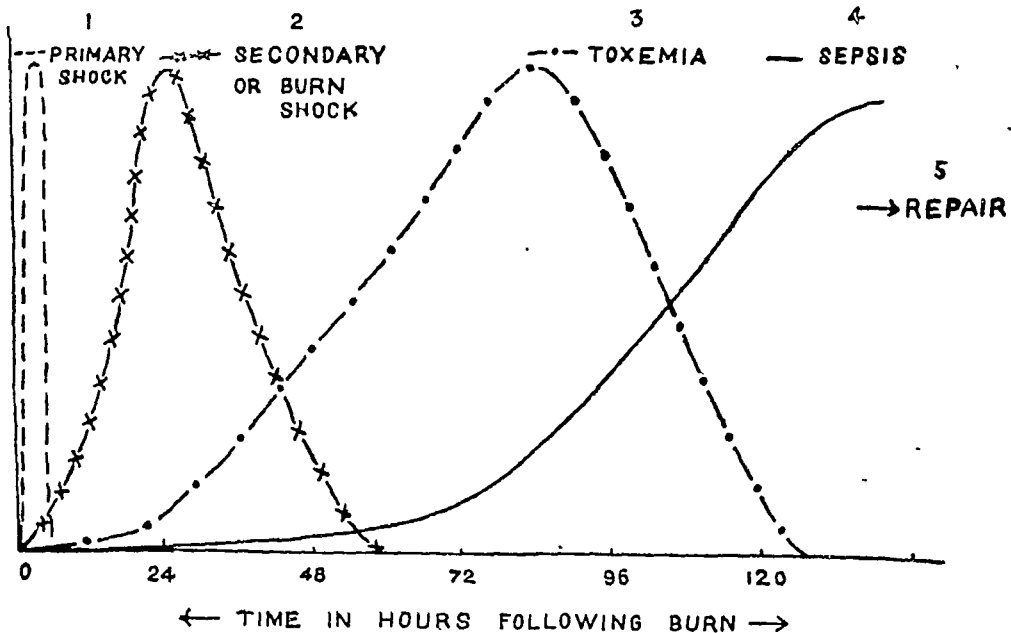


Fig. 1. Modified chart showing overlapping occurrence of the various states in severe burn (after Wilson).

morphia considerably lessens the primary shock. There is acute vasomotor paralysis from excessive stimulation of sensory nerve endings in exposed burnt areas. This pathologico-physiological process manifests itself in the well-known clinical picture of the burned patient lying prostrate, pallid, cold, with sub-normal temperature, rapid pulse and low blood pressure.

signs of collapse of the circulation ensue if it further falls to 60 mm. hg.

Blood pressure readings are of value in the estimation of the degree of shock; nevertheless they cannot be implicitly relied upon, as not infrequently one meets with cases of burn shock where blood pressure instead of being low may be normal or

in rare cases even high. Hence the importance of judging shock clinically. In this stage a patient, though alert mentally, has an anxious expression. He is pale and collapsed, skin is cold, pulse rapid and thready, respiration is quick, temperature sub-normal, and blood pressure is low and the urine scanty.

*Causes:* (a) It is due to great plasma loss from the circulation but not much from the body itself. It is mainly due to abnormal distribution—the plasma is lost in the body itself, in the tissues underneath the burnt area. It has been calculated that in the case of burns involving one-sixth of the body surface there might be as much as 70 per cent reduction in the circulating volume. It has to be appreciated that one pint of plasma lost to the circulation is more serious than a loss of one pint of blood. Plasma loss reduces blood volume and does extra damage by haemo-concentration while blood loss only reduces circulating volume. Therefore plasma loss actually should be more dreaded than a corresponding amount of haemorrhage. Further, the human body only has plasma in a quantity which is half the volume of blood and consequently can spare plasma less.

(b) There is pooling of blood in the capillary bed with increased permeability due to factors not yet fully known—perhaps due to absorption of products of tissue destruction and also due to loss of elastic pressure exerted by the intact and undamaged skin.

Loss of plasma produces increasing haemo-concentration, decreases circulating blood volume, lowers cardiac output, lessens the blood flow, and there is a secondary fall of blood pressure and secondary vaso-constriction. Therefore there is inadequate circulation to the whole body. There is inefficient oxygen carriage, starvation of tissues, irreparable damage to the organs of the body, fall of temperature and finally suspension of vital activities.

Damage to the liver as a result of burn shock must be well-appreciated. Failure of

the kidney resulting in oliguria and anuria occurs after the liver has been overwhelmed. Circulation to the kidney may be so retarded that renal function is almost or entirely stopped, and excretory products accumulate. If renal blood flow is cut off for a few hours, the kidney cells may be so injured that they never recover, and even if the general circulation is restored death in uraemia follows some days later. Therefore it is important to restore circulation promptly and in time.

3. *Toxaemia:* In this stage a patient may be irritable and distressed, complains of headache, and has a rapid pulse, elevated temperature, nausea and vomiting, loss of appetite, and a poor urinary output.

The toxaemia of burn is a widespread process involving many if not all the organs and tissues of the body. Toxaemia in an uninfected case is comparatively mild or absent. The nature of the toxins is still in undecided question. What are the products of cellular disintegration that are toxic to the body? Are they histamine like substances or protoenzymes? It is possible that enzymes or other substances liberated from damaged tissues but not coagulated by heat, towards the periphery of a severe burn, may themselves act as poisons.

*Causes:* Davidson has pointed out that there is alteration in blood chemistry as in the toxaemia of intestinal obstruction. He believes sodium chloride depletion plays an important part in the production of burn toxaemia. Blood chloride estimations are low, urinary excretion of chloride is also less, while chlorides are in abundance in oedema fluids at the burned area.

There is a marked similarity between the symptoms of adrenal deficiency,—low blood pressure, high haemoglobin concentration, low blood chlorides, anhydraemia, and occasional intestinal ulceration—and toxaemia of burn. Whether the toxaemia is partly due to the lack of adrenal cortical hormone in the circulation is still a matter for speculation. Swelling and haemorrhagic enlargement of suprarenal glands with focal necrosis are constant features at autopsy.



Damage to the liver, both functionally and histologically is usually mild if tannic acid is not used in the local treatment of burn. The liver also loses power to synthesize glycogen from glucose.

Damage to the kidney in the form of toxic nephrosis is a constant feature in fatal cases of burn.

### *Pathology of Repair of Burn*

This does not differ from the repair of any other accidental wound. Epithelial regeneration proceeds from the edge of the burn and from the islets of epithelium left on the bare surface—and from this epithelium differentiated structures of epidermis are formed. Repair of the dermis is in the usual way through the formation of granulation tissue and fibrosis with scarring.

Excessive necrotic tissue may hold up repair and prevent early elimination of infection.

Among the curative agents in the treatment of burn tannic acid produces some tissue damage and delays healing, the least toxic agents being sulphanilamides and penicillin.

### **Classification**

The well known Dupuytren's classification, over a century old, serves no useful purpose from a practical point of view and is now being discarded all over except for its historic interest.

Wakely has suggested a very simple classification of superficial and deep burn—superficial involving partial skin loss including the first three degrees of Dupuytren,

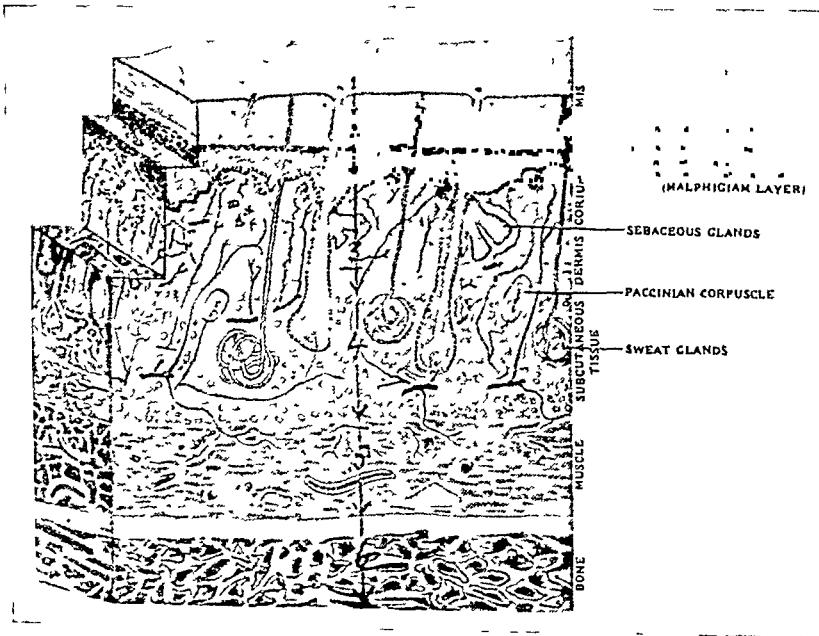


Fig. 2. Diagram representing classification of Burn.

The arrows indicate the depths of Burn according to Dupuytren's classification. The steps on the left represent the depths in the modern classification.

1. Superficial—1st degree.    2. Superficial—2nd degree.    3. Deep—3rd degree.

and deep burn involving complete destruction of the skin and even the deeper structure corresponding to the last three degrees of Dupuytren's classification.

From the clinical, therapeutic and prognostic points of view, taking into serious consideration Lehman's suggestion I have been lately classifying my cases in the following three clinical types:—

1. *Superficial*—1st Degree: The destruction extends down to but not involving germinal cells in the Malpighian layer. This may occur with or without blistering. It corresponds to the first and second degrees of Dupuytren's. The reason for combining the two degrees under one head is that there is little difference in treatment and none in prognosis. Further it can be clinically recognised on first inspection. In case of blistering, on the removal of blistered skin there is uniform redness or erythema in this degree.

2nd Degree: This corresponds to the third degree of Dupuytren's classification. Clinically in this degree, on removing blisters alternating red and pale areas give a recognisable mottling appearance. Clinicians have always considered this degree as a special entity. In this degree epithelium of the hair follicles, sebaceous and sweat glands is spared providing an opportunity for healing with patchy regeneration of epithelium and patchy scarring, as nowhere does the loss include the full thickness of the skin. It does not require skin grafting. Further, in this type sensory nerve endings are mostly exposed and therefore it is a most painful variety. This group requires protection from further damage by infection which may gradually destroy the epithelial remnants in the hair follicles, sweat coils and sebaceous glands.

2. *Deep*: This corresponds to the last three degrees of Dupuytren's classification. Clinically in this degree blisters are not always present and the appearance of the burnt area is one of dead-white pallor. In this type as the nerve endings are des-

troyed pain is less. Except those due to hot metal or some such thing, it is rare for any patient to have a deep burn without a surrounding area of second degree damage. It is often difficult and sometimes impossible to decide the true depth of destruction until the sloughs separate.

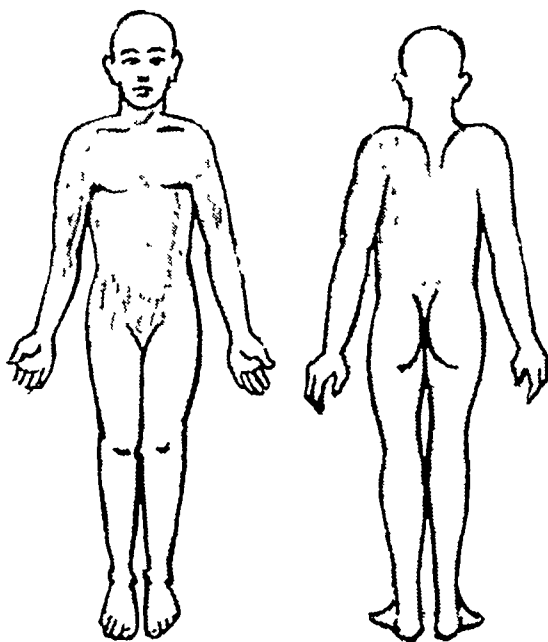


Fig. 3.

A chart for recording the extent of burn, using Berkows scale for estimating the extent:—

Head & Neck	6%	Anterior	20%
Trunk	38%	Posterior	18%
Upper extremities	18%	Arm & Forearm (?)	13½%
		Hand (?)	4½%
Lower extremities	38%	Thighs (½)	19%
		Legs (1/3)	12-2/3%
		Feet (1/6)	6-1/3%

Considering the fact that the extent of burn is more important than its depth, it is best that burns are classified by a combination of both depth and extent.

In estimating the extent of skin involved. Berkow's method is simple and practical and has been adopted (e.g. (1) 23 per cent

superficial 2nd degree burn, (2) 41 per cent superficial 1st degree and 25 per cent deep—mixed burn).

### Treatment

With a somewhat better understanding of the pathology of burns, it is possible to lay down definite principles regarding the general treatment. Our aim and object should be to save life, to combat shock, prevent toxæmia and infection, eliminate, or at least, minimise scarring, prevent contractures and deformities and restore normal physiological function of the body involved in the accident. There is considerable unanimity of opinion regarding the general treatment, but as regards local treatment there are many varied methods adopted by different workers, each claiming particular advantages for the method adopted, and still there is universal search for better methods. The last-mentioned fact shows clearly that this problem is far from settled.

#### *First Aid Treatment*

It is suggested that only the exposed burn should be covered and the patient wrapped in sterilised or freshly laundered clothes and taken to the hospital as speedily as possible for proper treatment—this is the best that the First Aider can do. If speedy transfer of the patient is not possible, it will be of great value to apply firm bandages which will limit the plasma loss that occurs in considerable quantities within the first hour or two after accident.

Where some delay is inevitable saline compresses and firm bandaging as a first aid measure is simple, somewhat efficient and possible of application in most instances and in most places.

All this should be done with thoroughly clean hands, and handkerchiefs to the patient's mouth and nose and to those of the First Aider's.

#### *General Treatment*

As has already been pointed out, the burnt patient does not pass from one phase

to the other but these phases overlap and perhaps they all even start from the very beginning of the accident. It is therefore apparent that a good plan will be to adopt all necessary therapeutic measures from the beginning.

Some cheerful and hopeful words from the Doctor will go a long way to keep up the morale of the patient who has been shaken with a severe and alarming accident. Injection of anti-tetanic serum is given as a routine. In an adult one-third to half grain morphia is given with 1/150 to 1/100 grain of atropine. Atropine to some extent checks the fluid loss from sweating. It may also be of value in cases of pulmonary oedema which sometimes occurs in burn cases out of proportion to the area damaged by burn. In such cases atropine alone is repeated.

After the first injection of morphia if the patient is still in pain it is probably due to failure of absorption of the drug in a shocked patient. To repeat morphia is to invite the grave danger of sudden absorption of the repeated, accumulated doses when shock abates and circulation improves. Some patients may be restless but are not in actual pain and often an urge to repeat morphia in these cases is erroneous.

The ill-conceived idea of keeping the shocked burn patient, as a routine, warm by many blankets with hot water bottles between, or by electric cradle, is to be condemned. We really aim at preventing further heat loss from chilling and checking outside cold having bad effect. There has been a tendency in the past to over do it. If you heat up your patient, at a critical time like this, more than half a litre of blood, so desperately needed by the body and vital centres, will flow to the skin where it would be lost causing further reduction of circulating volume—it might also lead to further fluid loss by sweating. The accepted practice of today is to keep the temperature of the burn-tent below the body temperature.

The burnt patient should receive fluid by mouth whenever he can take. This is only possible if the patient is not in severe burn shock. To give food and large drinks of any kind till the stomach is retentive, a condition that is generally obtainable only when the phase of shock has passed off, is to cause more and more fluid loss in vomiting. Even before the phase of burn shock is over, as soon as it is under control, oral fluids specially physiological electrolyte solutions are of great value as adjuncts.

As 80 per cent of the fatalities of burns are due to burn shock, prompt and effective treatment to save life should be our first and foremost object.

To combat and prevent burn shock, plasma transfusion is ideal and most logical. There is definite evidence available that the fluid loss from circulation in, under, and around the burnt area is plasma. All other substitutes must therefore be considered inferior.

In place of plasma, as inferior substitutes, bovine albumin, gelatines, and other synthetic colloids can be used.

Lately, however, there is growing evidence to show that in deep burn, loss of blood may equal or even exceed plasma loss. Therefore it is logical to give blood transfusions with equal quantities of plasma or normal saline in deep burn, a procedure that will fulfil the requirements better than plasma alone.

I must confess that due to poor supply only a few of our patients received plasma transfusions, and rarely anything like adequate quantities. Knowing full well the dangers of intravenous normal saline infusions during burn shock which might tip the balance against the patient by washing out the plasma proteins from the circulation into the damaged tissues, we have reluctantly used as a poor substitute for plasma ascitic fluid whenever available; and 6 per cent gum saline in other cases. The damaging effects of gum on the liver are not forgotten. Low content of protein in the

ascitic fluid has also not been lost sight of. In a few cases where we have used ascitic fluid, results have been satisfactory and I had not the occasion to regret its administration. Intravenous saline infusions are not recommended during shock, because they not only run right through the injured capillary walls but may also carry valuable blood constituents with them, leaving the blood more concentrated in red cells and lower in plasma volume than before.

In severe burn a rapid transfusion of about 500 c.c. of plasma is given intravenously. Only in rare extensive cases sternal or tibial transfusions are resorted to.

The foot of the bed is raised, limbs are bandaged if possible to squeeze some blood from the peripheral to the internal circulation. I must not fail to emphasise that the total effect of these simple and trivial procedures is not to be overlooked in such cases. At this stage, as we shall discuss in detail later, simple pressure treatment of burn is instituted. This is an important effort to check as far as possible the peripheral leakage which would be occurring while plasma is being transfused into the circulation. This early and prompt local treatment by pressure dressing not only seals off the burnt area rapidly before much plasma loss has occurred and helps the prevention of shock, but also works hand in hand with the general treatment in maintaining normal blood volume.

Plasma by drip method is now continued until the volume occupied by red corpuscles in oxalated and centrifuged sample of venipuncture blood in the graduated haematocrit tube shows the normal value of 45, and the blood pressure rises to above 100 m.m. hg.

Out of the many methods of assessing the quantity of plasma, whose quantity certainly varies from hour to hour in burn shock, I adopt the simple method of giving 50 c.c. plasma for every 1 per cent of burnt surface.

It is most physiological and also in conformity with the established clinical practice of keeping a diabetic patient on such doses of insulin that the patient is slightly on the side of hyperglycaemia than hypoglycaemia, that I prefer slightly less than the adequate quantity, and let my patient be on the side of slight haemo-concentration which in turn is a good physiological stimulus for reabsorption of plasma from the subjacent oedema of the burn.

In cases of severe burn requiring massive plasma transfusions, there is danger of pulmonary oedema after about 36 hours when reabsorption of the illdistributed plasma fluid from the burnt area may start. It is for this reason that Muirhead has suggested the use of plasma 3 times concentrated.

While adopting above measures oxygen inhalations are started early to prevent anoxaemia and tissue starvation specially in suffocated cases and those with lung complications.

For the proper care of the burnt patients, as suggested by Harkins and his associates, it is advisable to adopt, as a routine, the following :—

- (1) Chart pulse, temperature, respiration every two hours.
- (2) Record blood pressure every two hours during the first two days and thrice daily (8th hourly) during next 5 days. More frequent readings are required if systolic pressure is below 90 m.m. hg.
- (3) Record daily fluid intake and output.
- (4) Examine the urine daily—this is of special value if sulpha drugs are being used.
- (5) Examine blood for haematocrit index or haemoglobin percentage or red blood cell count—also total and differential count (to help detecting the untoward effects of sulpha drugs). This is done every third hour during first 12 hours and once a day for a week.

Among other measures occasionally adopted, mention may be made of intravenous injections of Eucortone (adrenal cortical hormone) 2c.c. repeated at 2 hourly intervals. This is an adjuvant of doubtful value. It has little to offer in the treatment of burn shock or toxæmia. Rhodes, Wolff and Lee in 1941 published encouraging reports; but the same writers later, in a large series, noted no benefit from the use of adrenal cortical extracts.

*Prevention of Toxaemia* : whether of biochemical origin or due to toxins of infecting organisms, demands proper and prompt treatment. In the state of toxæmia parental administration of 500 c.c. of normal saline for a few days is useful to counter the low blood chloride values. If vomiting is present 2 to 3 per cent hypertonic saline intravenously by drip method will replace chloride depletion and arrest it. As the liver bears the brunt of the toxæmia, addition of glucose to intravenous infusions at this stage will help the liver to cope with the toxins that have flooded the body of the patient.

To guard against the bacterial toxins, we attempt to prevent infection by early and judicious use of the modern chemotherapeutic agents and by mobilisation of the defensive mechanisms of the body.

In our series of cases early and proper use of penicillin and sulpha drugs gave good results by checking infection, and there was a considerable reduction in mortality.

With more patients surviving extensive and deep burns as a result of improved treatment, the question of anaemia of burn is assuming importance. It should be predicted and forestalled. It is due to external loss of blood, increased fragility and consequent destruction of red cells owing to widespread infection, and inhibition of the red cell regeneration as a result of toxæmia. Regeneration of red cells in a severely infected burn patient may be reduced to one-third of the normal. Further red blood cells of the transfused blood are also destroyed. Therefore repeated trans-

fusions alone will be of no use in the treatment of anaemia if infection is not prevented and dealt with at the same time. Pseudo-anaemia of haemodilution by reabsorption of plasma fluid from the oedema of burn occurs from third to sixth day and is due to increased plasma volume. This should not be mistaken for true anaemia. Hence the importance of correcting blood picture values with circulating volume.

During the healing phase not only anaemia but hypoproteinaemia and avitaminosis have also to be attended to. Excess of protein is required not only to meet the loss in exudate but also to cope with increased metabolism of fever in infected burn. Two-thirds of the sulphur in the body is estimated to be in the skin. For the proper repair of the skin in burn patients the value of sulphur containing foods like eggs cannot be over-emphasised.

Attention to the diet will have its own reward in rapid and early cure and better healing.

*Complications:* Toxic nephritis, toxic jaundice, septic Bronchopneumonia, and intestinal ulceration are the complications occasionally met with. They are becoming rather rare in burn cases in this anti-biotic era.

*Prognosis:* In determining the prognosis the extent of burn is far more important than its depth. While in the past one-third body surface involvement in adults and one-seventh in children usually proved fatal, at present due to better burn therapy even extensive burns involving 70 per cent or more of the surface may not be fatal. It is a well-known fact that children tolerate burns badly in general and of the chest and abdomen in particular.

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## LOCAL TREATMENT OF FRESH THERMAL BURN

*Local Treatment:* It is carefully correlated with general treatment and is executed concurrently with general treatment. In the early period a well-planned and properly and promptly carried out local treatment must aid the prevention of full establishment of shock.

I always had a feeling of great revulsion to the method of scrubbing of a burn patient. Certainly it is a most unphysiological attitude for a medical man and an unbecoming procedure for a modern Surgeon whose gentleness in the art of healing in other spheres of surgical practice has been the source of pride. Many a severely burnt patient whose life hung in the balance must have been tipped over by this procedure. It is gratifying that such a toilet and debridement of burn is now receiving universal condemnation. For many years I had performed a minimum of toilet and sparing debridement. The treatment of burn cases of the famous Cocoanut Grove disaster in November 1942 at Massachusetts General Hospital without cleaning and debridement provided moral support.

The burnt patient is laid over sterile sheets and is also covered with sterile towels. Medical attendants and the patient are all masked. Local treatment should be carried out with all the surgical cleanliness one requires for any major surgical operation, under morphia sedation only. Now run over a jet of warm normal saline over the burn area washing away loose dead tissue and at once dry with handkerchiefs wrung out in warm normal saline and gently pressed over the burn surface. Some more of the remaining loose dead tissues come out in this manner. I have never had occasion to regret not doing vigorous cleaning and thorough debridement. Thorough cleaning and debridement to my mind appear to be doing exactly the opposite of what it is intended for. In our attempt to clear the dead tissue, we cause more death

and damage locally, and a far greater damage to the patient in general by adding to his shock at a moment of grave crisis. We fail to eliminate infection and perhaps help the organisms to get into deeper layers and gain a foothold. In this way we interfere with the natural resisting power of normal skin cells and secretion. Only the healthy skin around the burn area is cleaned with rectified spirit.

The burn surface is frosted over with penicillin powder. Penicillin is mixed with any plain sulpha drug powder. 500 units of penicillin per gram of sulpha powder is a desirable dilution. Sulphonamide may be considered as a good diluent for penicillin rather than of any considerable value as local anti-biotic. Sulphonamides are valuable in suppressing the infection mainly due to the quantities absorbed into the blood from the raw burnt surface—a point that has to be borne in mind as large quantities used locally may produce alarming toxic blood levels.

When dealing with large surfaces in burns, I prefer to use penicillin in a cod liver oil and vaseline base, which is spread over evenly on vaseline gauze pieces and applied to the burn surface. I think the practice of spreading over penicillin ointment with a spatula over the raw surfaces should be discouraged as there is the possibility of infection being spread from one area to the other.

After frosting the surface with penicillin powder, I apply a couple of layers of cod liver-oilsoaked fine mesh gauze strips and a few layers of vaseline gauze are laid over. These, in turn, are covered by dry fluffy gauze and mechanic's cotton-waste, which act as good buffers and distributors of pressure. With all the care at one's command, and from below upwards, firmly and evenly, crepe elastic bandages are applied. Even when burns do not involve leg or forearm, bandaging should start from the tip of the extremities.

To prevent slipping of dressing, specially over the trunk, adhesive elastoplast is of additional advantage.

This non-adherent pressure dressing method popularised by Koch and practiced by us for some years is based on good surgical principle, although it requires meticulous care to be successful. It is a simple procedure and can be applied promptly and quickly before much of the fluid is lost, and is also a painless method. The common practice of the laity in applying oily substances as first aid measure does not interfere with the execution of this method. It is harmless, without any local or general untoward effects. It also aids in preventing and minimising further infection. As confirmed experimentally by Siler and Reid in 1942, it minimises plasma loss mainly by exerting pressure in the same way as the normal skin does and reduces capillary permeability of the tissue by raising the subcutaneous pressure, and to

some extent the oil with plasma on the burn surface produces a physico-chemical protective membrane. In this method most infrequent change of dressing prevents the constant danger of reinfection. It is a wise saying "Less often you dress a burn, faster it heals." It does not fix or destroy any viable tissue. It provides free and adequate drainage and prevents absorption of the septic exudate, if any, in the later part of the treatment. It can be easily removed and changed if severe infection occurs underneath. It shortens the period of treatment, and it is surprising how quickly the superficial burn has healed and the raw surfaces are available for skin grafting. If allowed to heal without grafting the scars are pliable and there is lesser tendency for contractures and keloid formation due to early removal of subjacent oedema.

While dealing with the burn of the extremities alone, specially that of the lower extremity, the same method and

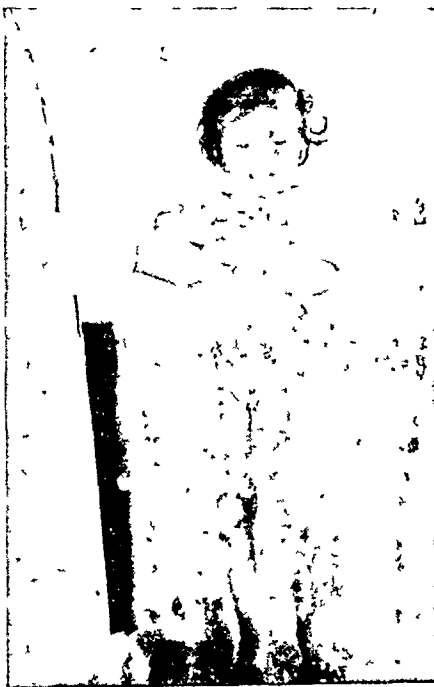


Fig. 4.

Shows the end result of closed plaster method of treatment for a highly infected deep burn of the left lower extremity.



principle is extended by using plaster of Paris in place of elastic bandages. The closed plaster method has given us very gratifying results in the treatment of infected burns of the extremity. The limbs are kept in the elevated position in the early part to avoid reactionary oedema. In the closed plaster method, the proteolytic action of pus is a valuable and important factor in the separating, dissolving and cleansing of sloughs. The dramatic results achieved in wound healing under closed plaster is now a well known and established fact. Repair of burns occurs in the same way as repair in wounds. There should be no hesitation in extending this very useful method to burn cases in increasing number. This method provides rest and comfort to the patient as well as to the medical attendant. Repair of the burn damage occurs under the best conditions, oedema and exudate are minimised, infection is controlled and reinfection is eliminated.

In fighting against infection, it is important to prevent further contamination of the burnt area; whatever organisms are already there should be starved by early and prompt removal of slough, attacked with sulpha drugs and penicillin and immunological processes in the patient should be bolstered by restoration and maintenance of physiological balance.

Infection, particularly with hæmolytic strepto-coccus and to a lesser extent with staphylo-coccus leads to delayed healing with excessive production of granulation tissue and produces scarring and contractures. Anti-biotics and chemo-therapeutic agents, to some extent, by inhibiting the growth of organisms produce rapid healing, lessen fibrosis and, consequently, even if healing has to occur with scarring, the scar is soft and pliable with lesser tendency to contractures and greater ability to withstand the trauma of ordinary use. Neither sulpha drugs nor penicillin exert more than limited control over the growth of bacteria in a deep burn. Therefore stringent precautions against contamination of

burns is essential, and hence the necessity for and the value of prevention is as great today as in the pre-antibiotic and chemo-therapeutic era.

For many years the surgical profession has been struggling about the problem of early disposal of sloughs in deep burns.

Connor and Harvey obtained good results with the use of pyruvic acid starch paste. In a few cases of burns in which I had the opportunity of employing this method, I was impressed with the rapidity with which sloughs separated in deep burns, and their early disposal provides surface available for grafting in the short period of about two weeks. In this method which can be employed as a useful adjuvant to the pressure method of treatment, there is no damage done to the living tissue and heal-burns, I prefer to use penicillin in a cod factory.

7 c.c. of pyruvic acid is added to 1 litre of distilled water. 100 gram of corn starch is mixed with 200 c.c. of diluted acid solution which is gradually mixed with 800 c.c. of boiling acid solution. The bowl containing this paste is cooled in ice. Vaseline gauze is applied right round the burned area, paste is thickly applied over the burn and covered with many layers of vaseline gauze. This is essential to prevent drying of paste between dressings which are done about 2 to 3 times a week.

This acid debridement appears to be dependent on the maintenance of correct supply of hydrogenions over a sufficient period of time. Evidence is also available that the effects are not specific to pyruvic acid, and that phosphoric acid solution is as good if not better. Further, starch as a vehicle is being replaced for convenience by several others for example Cellulose Gell, jellies, etc.

The most recent advance in connection with the deep burn appears to be the practical application of surgical debridement of even extensive areas with immediate skin grafting. Unfortunately I did not have an



Fig. 5.

A case of a mixed burn where sloughs have been quickly separated in two weeks and the superficial burn is healing satisfactorily. (Pyruvic Acid Debridement)

opportunity of performing this in any of my cases.

The other methods are dealt with briefly :—

1. *Bunyan Envelope Method*: In this method the part to be treated, specially extremities, is enclosed in specially treated waterproof silk envelopes. Irrigation with electrolytic sodium hypochloride solution (Milton's solution) was originally used. Initial irrigation is done with 1 in 5 and subsequently with 1 in 20 thrice daily. Now saline irrigations are performed. Thorough drainage after irrigation is important. Envelopes are filled with warm air or oxygen in the intervals. The patient is encouraged to move his hands or limb and to use his fingers or toes, while in the envelope, from the very start. It is, therefore, that the patient does not lose confidence or become depressed. It has also the advantage of being painless, easily and quickly applicable and the process of repair can be watched through these envelopes.

2. *Saline Bath Method*: So popularly used by Dermatologists in Vienna for the treatment of severe burn cases requires

considerable nursing care, well-trained team of workers, and specially equipped burn centres.

During the last war, the low incidence of pain and shock among the burn casualties while in the salt water of the sea attracted attention to this mode of treatment.

The patient is given local or general warm saline bath as the case may be for one hour three times a day. Arrangements for the continuous flow of saline through the tub is useful. At each bath, the patient is thoroughly cleaned of all dead and necrotic tissues. In the interval tulle grass is applied over the burn, saline soaked compresses are applied and not permitted to dry by second hourly moistening and covered by some impervious material like oiled silk. This method is not advisable in the early stages of shock.

The above-mentioned two methods may be of some value in a few cases but cannot be recommended for all types of burn. Irrigation of abscess cavities, empyema, wounds and osteomyelitic cavities is being abandoned. They have, however, a useful place in the later stages of the treatment

when preparing the granulating surfaces for skin grafting.

3. **Tannic Acid Treatment:** Introduced in 1925 by Davidson, is not being practised today. While his method of treatment by tannic acid alone or in combination with silver nitrate and other substances is now dead, the great influence on the problem of burns, the awakening interest in the various aspects of burn therapy created by him will always remain alive.

Tannic acid which in the past was considered a safe and suitable coagulating agent has now been proved to be a toxic substance

proportionate to the amount of tannic acid used. Experimental and clinical observations conclusively prove the great damage tannic acid causes to the liver. Tannic acid considerably retards healing, it causes unnecessary destruction of viable tissue. It does not stop the exudation that continues beneath the coagulum during the burn shock. There is also absorption of tannic acid from the deep surface of the eschar that constantly undergoes liquefaction—this process is accelerated if sepsis establishes itself. Sepsis under the eschar is difficult to control. Healing under the tan is slower and separation of slough takes longer.

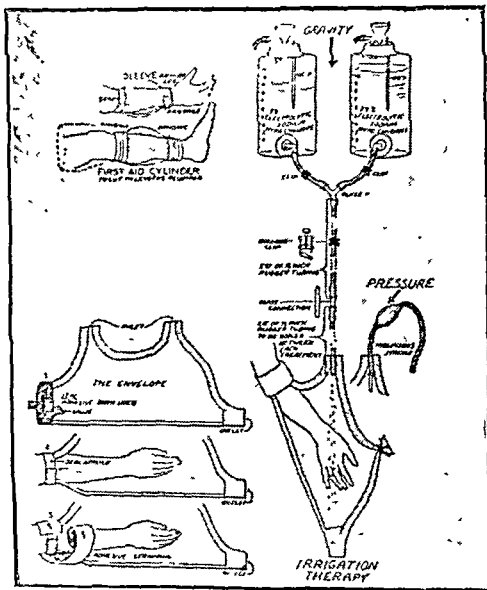


Fig. 6.

Use of Bunyan envelopes—method of application and irrigation (from Military Surgical Manual V). Envelopes applied (from Medical Annual 1943).

itself. There is post-mortem evidence of liver necrosis in 60 per cent of fatal cases after tanning. No necrosis was observed in the remaining cases, where tannic acid was not used. However it cannot be lost sight of that in untanned cases, death occurred within 24 hours while in those treated with tanning; it occurred between the 3rd and 7th day. Experimentally, in rats, the degree of hepatic damage was found to be directly

Tannic acid when applied in concentrated form may penetrate before superficial coagulation and produce deep caustic effect (Schentz). Through the crack in and around the eschar if not sealed from time to time, by sulphanamide powder or gentian violet, infection is liable to occur. Further this method is unsuitable for the face on account of its splinting action, and on the

fingers its constricting effect may imperil vascular supply and lead to gangrene.

4. *Aniline Dye Methods*: These were recommended for their antiseptic value in preventing infection and also for the thin, light and pliable eschar that does not crack.

Aldrich suggested treatment by 1 per cent gentian violet second hourly spraying for the first 24 hours and 4 to 6 hourly as required later.

Turner claimed good results with 2 per cent mercurochrome. This, he claimed, had the advantage of being transparent and pus could be detected early.

Wakeley suggested tanning by triple dye.

5. *Occlusive Dressing Methods*: Among the occlusive dressing methods mention may be made of paraffine mixture (with vaseline, cod liver oil, sulphonamide, and with traces of camphor, menthol and eucalyptus oil) spray revived by Pendleton of U. S. Navy of what was extensively tried in the first world war. Paraffine wax mixture is sprayed without debridement. Wax film is melted away by special heat bulb cages before second spraying. During this procedure melting wax carries away with it dead and damaged tissues. Spraying is done daily. In minor burns this mixture can be conveniently applied with a shaving brush.

Pickrell, spraying sulphadiazine with triethanolamine, methyl cellulose, sorbitol, and acetone produced a pre-formed membrane for pressure dressing of burn cases with good results.

Covering the burn with coagulated plasma, serum, and other blood products have been used as physiological dressings.

Recently Chase of Detroit, Michigan, has suggested the new protein eschar technic with or without pressure dressing. He claimed that extract of Aorta in saline spray or in the cream or ointment base with penicillin added will prevent the oozing of plasma like fluid from the injured surface which occurs when ordinary pressure

dressings are applied. Further this eschar is claimed to prevent air-borne infection which may occur when changing pressure dressings.

Considering the poor facilities available in most places in this country, barring a few exceptions, many of these methods are not quite practicable.

Irrespective of the site, extent and duration of burn, the simple non-adherent pressure dressing method, with some modifications to suit a particular case, can be universally adopted with good results. The loss of circulating fluid can be considerably reduced by the pressure dressing and is therefore a valuable step towards preventing and combating burn shock. Scarring is considerably less when this method is used because the firm elastic pressure prevents plasma loss and removes early what protein fluid has already extravasated in the tissues subjacent and around the burn, and in this way does not provide a favourable medium for the proliferation of fibroblasts. This method has the merit of simplicity and a high degree of success to its credit provided the surgical principles involved in its application are properly and faithfully attended to.

It is a well-known fact that infection of the burn wound is best treated by prevention. If it requires an operating theatre, why should there be no special burn rooms in our hospitals where every thing could be done to treat burn case under the same aseptic precautions as for an abdominal operation?

Among other infecting organisms that might get a foothold in the burn and are most difficult to eradicate are *B. pyocyaneus* and *B. proteus*. Occasionally *B. coli* gain entrance to the burns involving the areas near the anus. Neither penicillin nor sulpha drugs are of any value in eradicating the common pyocyaneus organisms.

Application of 1 per cent acetic acid, urea formic iodide, or painting the surface thrice daily with 5 per cent gentian violet

helps in removing these organisms, if used along with the saline soaked dressings.

The longer the burn surface is allowed to remain, the greater is the risk of further infection and contamination, hence the need for early skin grafting.

### *After Treatment*

Wakeley considers that a follow up is just as important in burns as in fractures, if anything is to be learnt about the best forms of treatment and their end results. In this connection the best I can do, is to



Fig. 7-a.

Fig. 7-a shows a girl who had extensive mixed burn depicted in diagram 2 according to Berkow's scale. Skin grafting was refused.



Fig. 7-b.

Fig. 7-b. same girl some years after.



Fig. 7-c.

A good after-care with nightly rubbing of lanolin resulted in a good supple scar as shown in Fig. 7-c.

offer an apology, because neither have we an establishment for follow up, nor there is a response from the patients discharged from the Hospital. All the burn cases are advised to rub in lanolin every night, as soon as the burn has healed. This simple procedure helps to improve blood supply and lymphatic drainage of the burn scar, and keep it soft and pliable.

Figs. 7-a, b, & c shows a girl who was the victim of a mixed burn. She required skin grafting to prevent excessive scarring. However, in this case all persuasions failed and the deep burn was allowed to undergo natural process of repair by the formation of scar tissue, yet a very good after-care with nightly rubbing in of lanolin for a long period, has resulted in a good supple scar, able to withstand the tension and trauma of the active life of a school girl.

Superficial X-ray therapy is of value in the treatment as well as in the prevention of keloid scars. It is also useful in suppressing the excessive collagen formation that may occur between the sheets of skin in extensively grafted cases.

*(To be concluded.)*

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## ANAESTHETIC ACCIDENTS\*

by K. P. GANDHI.

Accidents occurring on the operation table in relatively healthy individuals are tragic happenings, enough to shake the nerves of seasoned and experienced surgeons and anaesthetists. In almost all such cases the disaster can be attributed to the improper handling of the patient before and during the operation by the anaesthetist.

Proper preoperative care will materially help to reduce the incidence of these accidents. It is imperative to find out gross deficiencies in any of the vital functions by a routine preoperative check-up. Proper preanaesthetic medication help to reduce the reflex irritability of the central nervous system and ensures an easy induction and maintenance of proper level of anaesthesia which necessarily varies during the different phases of the operation. The usual story is that every thing was going on well with the patient when a sudden deterioration occurred, which ended fatally inspite of all efforts at resuscitation. Truly-speaking in a majority of cases it is not so. The theory of suddenness cannot be sustained when one reflects on the sequence of events, which led to the disaster. Proper selection of the anaesthetic agent and the technique of administration are all important. Due care should be taken to maintain an unobstructed airway by preventing the tongue falling back and by removing the mucus and other accumulations, if any from the throat; and attention should be paid to the proper plane of anaesthesia for the work going on, proper position on the table, adequate oxygenation, and avoidance of overdosage.

The writer does not wish to enter here into the details of prophylaxis and treatment of such tragedies on the operation table but wishes merely to record three cases which have left a long lasting impression on his mind. Of these three, the first two were cases of general inhalation anaes-

thesia, and the third one a case of intravenous Penthothal sodium.

The first case was of a fair looking healthy boy four years old, born in England of well-to-do parents. The patient was admitted into a public general hospital in May 1931, for removal of tonsils and adenoids. Atropine Sulph gr. 1/200 was ordered one hour before the operation. Patient was drowsy when put on the table. The anaesthesia was induced and maintained by open inhalation of Ether and Chloroform (4-1). A folded sheet was put under the shoulders, and a mouth gag was applied. The right tonsil was removed with a guillotine and a sponge on forceps was put into the fossa. At this time it was noticed that the patient was getting cyanosed and after two or three jerky respirations stopped breathing. The head was lowered, the sponge forceps removed, the pharynx mopped, a tongue clip was applied and artificial respiration and oxygen started. The pulse was good. Lobeline 1 c.c. was given subcutaneously. Two or three minutes passed away without any result and the patient's colour deteriorated further. His pupils were dilated. Adrenaline Hcl 1 c.c. was injected intramuscularly and the anal sphincter was dilated. After five minutes the patient's pulse became irregular and feeble. Out of desperation, artificial respiration was given at a faster rate and more forcibly. Another lobeline injection was given. At long last the patient took one inspiration, stopped for about ten seconds and then began to breathe again. In about two or three minutes, slow but, regular respirations started, cyanosis cleared away, pulse became regular and the patient was fairly out of anaesthesia. The left tonsil and adenoids were removed. The patient did not give any more trouble in the wards, and was discharged next morning. On going to the wards and making inquiries, it was definitely ascertained that the child had

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been given one hour before the operation, half a tablet of a combined tablet morphine sulph gr.  $\frac{1}{4}$  and atropine sulph gr.  $\frac{1}{150}$  subcutaneously instead of atropine sulph gr.  $\frac{1}{200}$  as ordered. One is inclined to conclude that morphia gr.  $\frac{1}{8}$  had a good deal to do with the drowsy condition of the child and was responsible for the depression of the respiratory centre. A little chloroform in the mixture also might have contributed to some extent to the depression. The pulse was good for a fairly long time.

In children the respiratory system is very unstable. Besides the tracheobronchial tree in a child is very narrow. For these reasons morphia should be avoided in children under ten years for any operation, and more so, for operative procedures round about the airway. Throughout, children should be tactfully handled and the anaesthetic should not be forced upon them. Some sedative and amnesic drug should be given before the anaesthetic, otherwise, they might get some sort of a psychic trauma, which might be very harmful, if later on in life they have to undergo some other operative procedure.

This sedative and amnesic state can be easily ensured by barbiturates in one form or other, such as syrup of nembutal or a capsule of nembutal. Where a capsule is not practicable powdered nembutal may be administered with some honey or some tasty jam. Paraldehyde is also suitable for children particularly as it is not a respiratory depressant.

The second case was of a man aged fifty-five years, with right sided submaxillary cellulitis of a week's duration. The patient had difficulty in breathing for the two days preceding. There was sugar and albumin in the urine; B.P. 150/90. The patient's condition was very low and he was able to open his mouth to half the normal limit. The surgeon informed me a day before the operation that several consultations were going on regarding the case and if the patient should survive these consultations the operation would be undertaken.

The next day the patient was better. Morphine sulph gr.  $\frac{1}{4}$  and atropine sulph gr.  $\frac{1}{100}$  were given half an hour before the operation. Besides the surgeon his assistant and myself, a consulting surgeon, and a physician were asked to stand by to look after the patient. The consulting surgeon asked me what anaesthetic I intended to use. I told him that I intended to give cyclopropane and oxygen. He advised me against a general anaesthetic, as he had a very bad experience in such cases, and had lost a case. The patient was made to lie down with a pillow under his head. He was not particularly dyspnoeic. As advised, I did not use general anaesthesia. The incision was made under local ethyl chloride, some pus was evacuated and the incision was explored by the finger. Naturally the patient did feel some pain. As the bandage was about to be applied, the operating surgeon asked the visiting surgeon whether he would like to verify the extent of the lesion. He put in his finger and began exploring. Patient was very uncomfortable and began to move his limbs. I put on an open mask and sprayed a little ethyl chloride. The patient after a little struggle held his breath and cyanosis began to appear. The jaw was in spasm, and could not be opened. Oxygen was run in through a nasal catheter and the head was lowered. 1 c.c. lobeline was given subcutaneously. The pulse was good. Corneal reflex was absent and pupils were dilated. Artificial respiration and 1.7 c.c. of Coramine were given and anal sphincter was dilated. By now the patient's mouth could be opened and an attempt was made to pass an endotracheal catheter with the head low. I could not identify the structures. Very often in these cases there is oedema and distortion of the pharynx and larynx. The pulse was getting weaker and coramine was again injected intracardially. It was now over six minutes. Though the heart was beating for over five minutes, all routine measures failed to start respiration and the patient expired.

It was a case of laryngospasm brought about as a result of the irritant effect of



ethyl chloride vapour on a larynx already narrowed and distorted due to oedema caused by neighbouring inflammation. An immediate stab tracheotomy might have saved the patient, at least for the time being. Whether operative interference in the region of the carotid sinus and carotid body contributed towards the disaster, it is difficult to say.

A few months after this incident, I came across an article, where the writer had one death and one narrow escape during anaesthesia for drainage of abscess of the sub-mandibular space. Thereafter in his next four cases he successfully adopted the following technique:—

10% aqueous solution of Cocaine Hcl is sprayed in the nose and pharynx. After fifteen minutes Magill's endotracheal catheter is passed under direct vision with a thin bladed laryngoscope. An analgesic ointment\* is applied to the tip of the catheter to facilitate its longer retention if necessary. Blind intubation does not succeed due to oedema and swelling round about the pharynx and larynx. The gas machine is connected to the endotracheal tube and gas oxygen and if necessary a little ether is given, using a semiclosed system. In this way the surgeon is able to deal with the lesion with deliberation and hence able to prevent further extension of the disease. After the operation an oxygen mask of the B-L-B type is fixed over the catheter and oxygen administered in the wards continuously if necessary. If it is advisable, the tube can be kept safely for over a day. The next day, if necessary, the gas machine can be attached and dressings changed under gas oxygen analgesia, since the analgesic ointment applied to the tube favours its retention without discomfort.

This appears to be an elaborate procedure for an incision of an abscess, but it is the safest course to adopt, if the patient is to be operated under general anaesthesia. The

surgeon can deal with the lesion more deliberately than when local ethyl chloride is used.

The third case was of a boy A.S. aged 12½ years with bilateral ankylosis of the temporo-mandibular joints as a result of a fall on the head three years before. The operation proposed was excision of the condyles in two separate stages. The general health was fairly good. Since the fall, he had been unable to open his mouth completely. The maximum interval that could be obtained between the opposite rows of teeth, was about half a centimetre. B.P. was 110/70. There were no other abnormal findings.

The proper selection of the anaesthetic agent and technique was important, because the ankylosis led to difficulty in the maintenance of an airway. Endotracheal anaesthesia appeared to be the best under the circumstances but there was no space to introduce the laryngoscopic blade and direct vision introduction was out of the question. I was not quite sure whether I could do a blind naso-tracheal intubation. If the blind attempts were not successful, it was possible that some oozing from the nose and throat or some mucous secretions might gravitate towards the larynx, setting up a varying degree of laryngospasm right from the start and thus interfering with proper oxygenation of the patient. That is why, it was not attempted and in the end it was decided to give Penthothal Sodium intravenously.

On 11-10-1946, at 8-30 a.m. Atropine Sulph gr. 1/100 was given, half an hour before operation. The operation was on the right temporo-mandibular joint and so the head and face were turned towards the left side. Patient was in the recumbent position. 3½% solution of Penthothal was started intravenously. During the course of the operation, the mandible was elevated by fingers passed under sterile drapes. Patient was having a fine stream of oxygen through the nose. The operation was over

\*1 per cent DIOTHANE ointment with oxyquinoline benzoate. (MERRELL)

in fifty minutes without the slightest incident. Patient had in all 1.2 gm. of Penthothal. 50 c.c. of 25% glucose solution was given through the same needle and the patient was sent to his room. Within half an hour, he began to move his limbs and then made rapid recovery.

At 9-00 a.m. on 17-10-46, the left side was taken up. B.P., premedication, and the position were the same as on the previous occasion, with the patient's head and face turned on the right side. 3½% Penthothal Sodium was started intravenously and oxygen intranasally. After about 30 minutes he showed cyanosis which cleared up in a couple of minutes by pulling out the tongue and increasing the oxygen flow. The operation was over in about the same time as on the previous occasion with approximately 1.2 gm. of Penthothal. 100 c.c. of 25% glucose was started intravenously through the same needle. In the meantime the head was turned from the right side and kept straight in the middle line to inspect and remove sutures from the right side which was operated on the previous week. While these things were done, it was noticed that the patient was not breathing and was cyanosed. The head was lowered, tongue pulled out, artificial respiration and coramine 1.7 c.c. given. Patient started breathing again in half a minute and continued to breathe in a depressed way. Dressings were applied and patient was shifted to his room with the mouth gag and tongue clip on. The foot of the bed was raised and oxygen continued. At 10-15 a.m. B.P. was 80/55; pulse 130 and respiration 16. From now onwards mucous secretion appeared in the throat and suction was kept up intermittently. Pupils were not dilated and there was no corneal reflex. 5% glucose saline was going on intravenously. Another 1.7 c.c. of coramine was given intravenously.

Patient's colour further deteriorated, breathing became irregular, slow and laboured and he continued to secrete a lot of mucous, which was being sucked away. At about twelve o'clock endotracheal catheter was passed blindly. Between 11

a.m. and 12 noon, many times his condition was very serious. At 12-15 p.m. B.P. was 110/80; P. 140; R. 16, and now as the patient was getting a rigor, saline was discontinued. After sometime plasma was started. In all 500 c.c. were given intravenously. Corneal reflex appeared. There were half hourly recordings, which showed B.P. going to 145/85 and pulse coming down to 126 with respiration 20 per minute. At 2 p.m. he began to move his limbs. At 3 p.m. he woke up and became extremely restless and complained of intense thirst. Water was given. After 3 p.m. the patient appeared safe and passed urine. The patient had temperature during the first 36 hours the maximum going to 102°F. After this period it settled down to normal and there were no post-operative or any other complications. Patient went home on 22-10-46.

1.2 gm. Penthothal proved to be more than what the patient could tolerate. In short, it was an overdose. Before the operation, it had been decided to keep the patient properly under anaesthesia and not to allow him to come out of the anaesthesia at any stage during the operation, for fear of nausea, cough, sneezing or such other disturbances. Penthothal is a vagotonic drug and an adequate dose is required to do away with these reflexes. Sometimes they are excited by trauma on sensitive parts, when the patient is in a lighter plane of anaesthesia. As the operation was on the face, it would have been difficult to attend adequately to these disturbances without encroaching on the operative field.

When the glucose was being given and the patient's head was in the middle line, the airway was neglected for a couple of minutes; the jaw having become mobilised, allowed the tongue to fall back easily, and brought about cessation of respiration. With prolonged administration of Penthothal, it is very advisable to keep a good watch on the patient's airway for some time after the operation till the reflexes re-appear.

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# A STUDY OF THE LONGITUDINAL ARCH OF THE FOOT\*

by A. K. BASU.

## Introduction

The subject of the arches of the foot present and has presented considerable points of controversy. The text books of Anatomy usually omit to mention these controversial features, speak of the arches as a series of static structures and are content with describing what they call their usual and standard forms and types. As the anatomical writers draw their inspiration from dead subjects, their description of the arches of the foot are designed to conform to limited standards and suffer from the discrepancy of having to deal with a static structure as against a dynamic one which the human foot essentially is. The usual anatomical description is that there are four arches in the foot.

- (1) Medial longitudinal arch.
- (2) Lateral longitudinal arch.
- (3) Posterior transverse arch.
- (4) Anterior transverse arch.

The medial arch is made up by the calcaneus, astragalus, navicular, the three cuneiforms and the 1st, 2nd and 3rd metatarsal bones. Its summit is at the superior articular surface of the astragalus and its two extremities or piers on which it rests in standing are the tuberosity of the calcaneus posteriorly and the heads of the 1st, 2nd and 3rd metatarsals anteriorly. The lateral arch is composed of the calcaneus, cuboid, and the 4th and 5th metatarsal bones. Its summit is at the talo-calcaneal articulation.

The posterior transverse arch is a half dome and if the two feet are placed side by side, the complete arch extends from the base of one to that of the opposite 5th. The anterior transverse arch is a complete arch and extends from the head of the 1st metatarsal to the head of the 5th metatarsal bone.

Anatomical text books again make no distinction between the factors which are

supposed to be responsible for the maintenance of the arches. According to Gray<sup>34</sup>—"the chief characteristic of the longitudinal arch is its elasticity due to its height and to the number of joints between its component parts. Its weakest part is the joint between the talus and the navicular bone and this is braced by the plantar calcaneo-navicular ligament which is elastic and is thus able quickly to restore the arch when the disturbing force is removed. This ligament is strengthened medially by blending with the deltoid ligament and is supported inferiorly by the tendons of the tibialis posterior, the flexor digitorum longus and the flexor hallucis longus. The arch is further supported by the plantar aponeurosis, by the small muscles of the sole of the foot, by the tendon of the tibialis anterior and by ligaments of the articulations involved. The lateral arch is supported by the long plantar and the plantar calcaneo-cuboid ligaments, the tendon of the peroneus longus and the short muscles of the little toe".

Fraser<sup>30</sup> likens the arches of the foot to stone arches composed of several segments and says that like the latter they can be secured in three ways.

- (1) Inter-segmental ties.
- (2) Ties between the pillars.
- (3) Strap under the highest part of the arch.

For the medial longitudinal arch the inter-segmental ties are represented by the ligaments connecting the articulating bones—the ties between the pillars are provided by the muscles and fasciae extending between the tuberosity of the os calcis and the great toe along the inner side of the foot and the strap under the arch is the expansion from the tendon of the tibialis posterior to the cuboid passing under the head of the astragalus. Similar methods of anchorage apply to the lateral and transverse arches.

In Buchanan's anatomy<sup>12</sup> the longitudinal arch is described as before as being composed of medial and lateral segments but the transverse arch is present only at the

\*A thesis submitted for the M.S. Degree of Calcutta University.

distal end of the tarsus and the proximal end of the metatarsus and there is no mention of arching at the heads of the metatarsal bones. The longitudinal arch is also mentioned as being supported by the plantar calcaneo-navicular ligament, the tendons of long flexor muscles, by the flexor digitorum brevis, by the long plantar ligament and by the plantar aponeurosis which plays the part of a string to a bow and prevents undue separation of the two pillars.

In Cunningham's Anatomy<sup>19</sup> the opinion is expressed that the most important factors responsible for the prevention of excessive flattening of the arch lie in the plantar concavity; they are the plantar calcaneo-navicular, the long plantar ligament, and the plantar calcaneocuboid ligament. The various slips of the tendon of the tibialis posterior, as they pass to find attachment to the different tarsal and metatarsal bones give additional support. The plantar aponeurosis is also an important factor, for as it extends between the two pillars and is attached to both, it operates in the same manner as the "tie beam" of a roof.

Callender in his text book of Surgical Anatomy describes a high medial longitudinal, low lateral longitudinal and a transverse arch which is relatively high and narrow in the middle of the foot where the wedge shaped middle and lateral cuneiforms are strong. The forward part of the arch is broad, flat and weak. It often gives way letting down one or more of the metatarsal heads beneath which painful callosities form. The maintenance of the arch he ascribes to the ligaments which are said to act only as passive agents, in contrast to the muscles, which take an active part and are indispensable for the maintenance of the proper shape of the arch. Because of the elasticity of the ligamentous apparatus, the arches flatten out when the foot has to sustain a heavy weight but regain their original shape immediately the weight is removed.

Quain's anatomy<sup>66</sup> says that the longitudinal arch when the foot rests on an even

surface is supported by two piers, a posterior formed by the tuberosity of the calcaneus and the anterior formed by the heads of the metatarsal bones which all lie practically in the same horizontal plane. The weight of the body is transmitted through the talus to the arch not at its highest point which lies in front of the bone but rather behind it and is conveyed to the posterior pier through the calcaneus. This bone which is tilted upwards in front is supported by five ribs which merge behind, diverge in front and individualise themselves in the five metatarsal bones which with the cuneiform bones and cuboid are bound together transversely in a transverse arch. The weight is distributed equally along the five ribs to the anterior pier of the arch and causes a certain amount of flattening of the transverse arch and spreading of the heads of the metatarsals. The longitudinal arch is supported by strong plantar ligaments especially the plantar calcaneo-navicular and calcaneo-cuboid. Of special importance according to Fick is the lateral part of the plantar calcaneo-navicular ligament. The ligaments are assisted by the strong plantar fascia and the tone of the muscles is also an important factor. The transverse arch is supported by the transverse plantar bands and the interosseous ligaments, while the crossing in the middle line of the foot of the tibialis posterior must also play a useful part to the same end.

Piersol's Human Anatomy<sup>64</sup> says that the arches depend very much for their stability on the action of the peroneus longus and the tibialis posterior which pull against each other from opposite sides. The former is efficient in maintaining the transverse arch, the latter in maintaining both the transverse and the antero-posterior. To these should be added the plantar fascia and the muscles to the toes arising from the calcaneum.

Morris's Human Anatomy (1925) edited by Jackson mentions the following factors as being responsible for the maintenance of the arch.

(1) Plantar fascia binding the pillars of the longitudinal arch.

(2) Plantar calcaneo-navicular ligaments.

(3) Tibialis posticus—of the numerous offsets of this muscle that to the navicular is the most important. By coming into action when the heel is raised, this tendon helps the calcaneo-navicular ligament to support the head of the talus and to maintain the arch of the foot when the weight of the body is thrown forward on to the instep. In other words, the tibialis posterior comes into play just when the heaviest of its duties is devolving upon this ligament, viz. when heel is being raised and the body weight is being thrown over the instep on to the opposite foot.

(4) Calcaneo-cuboid ligaments—long and short.

(5) Peroneus longus—this raises the lateral pillar and steadies the lateral side of the arch. Further by its strong process attached to the first metatarsal bone, it keeps the great toe strapped down firmly against the ground and thus keeping down the anterior pillar of the longitudinal arch, it aids the firmness of the head.

(6) Tibialis anterior—this braces up the key stone of the arch. Thus by keeping up the first cuneiform, it maintains the navicular and so indirectly the tarsus in situ.

It will be realised from this brief review of anatomical literature that the general anatomists make no distinctions between the ligaments, fasciae and muscles as such in their role of sustaining the arches especially the longitudinal arch. They are considered to be equally responsible and one is as important as the other.

It is when we come to consider the arches of the foot from the orthopaedic point of view that differences arise and among the writings of the orthopaedic surgeons marked and fundamental divergences as regards the nature, structure and the means of maintenance of the arches of the foot and the reasons for its lowering and flatness are

manifest. Some like Norman Lake would like to consider the arches especially the longitudinal arch as having been built on a structural basis and so depending for its security on bony configuration and ligamentous support; the muscles coming only as auxiliaries lending support by their contractural tonus especially in certain phases of locomotion when the whole strength falls on the anterior portion of the arch of the foot—the os calcis and the heel being off the ground. The opposite point of view is supported among others by Bankart, who considers the permanent rigid arching of the foot as a contractural deformity brought about by continual wearing of rigid shoes—the price of civilization. To them the normal foot is perfectly supple, capable of assuming an arched form and lowering it at will. The arching is the result of the postural tone of the “antigravity” muscles—the ligaments under normal circumstances bear no strain and the failure of the arch and the consequent foot strain occurs when the postural tone of the muscles gives way and the ligaments are made to bear the strain of the body weight. The points of controversy as regards the arches of the foot and especially the longitudinal arch between these two schools of thought may be summarised as follows.

(1) Is the longitudinal arch of the foot always present?

(2) Is the longitudinal arch of the human foot one of its structural features or is it a structural abnormality brought about by continual wearing of rigid shoes?

(3) On what does the longitudinal arch depend for its maintenance—whether on bony configuration, ligamentous support or muscle tone?

(4) What are the causes of the lowering of the arch and of foot strain?

The differences between the two schools of thought are fundamental. To one the rigidity and the arching of the adult human foot is perfectly normal, permanent and a static anatomical feature. “The evolu-

tionary destiny of the human foot is to the production of a rigid structure having an arched form but devoid of any movements other than those at the ankle and the toe joints. The adoption of the unyielding and limiting foot wear by man was functionally but an anticipation of a general evolutionary trend" (Lake).

The other school considers the permanent unalterable arching of the adult human foot as an abnormal phenomenon produced by the continual use of rigid foot wear. They also hold that the normal arch should be flexible and depend mainly for its maintenance on the postural tone of the muscles; the ligaments or the body configuration are of secondary and small importance.

The purpose of my thesis is to find out the truth between these divergent opinions. I have approached the problem from three directions.

- (1) From the clinical point of view.
- (2) From the embryological point of view.
- (3) From the evolutionary point of view.

The clinical portion of my work was done at the Sambhunath Pandit Hospital, where I have made free use of all the materials available, patients, nurses, doctors, menials, etc.

For the last part of my work I attended the Zoological and the Anthropological departments of the University of Calcutta. I also examined a specimen of the Zoological department of the Benares Hindu University. In the first two places I was allowed to make free use of the Museum specimens and the accompanying diagrams are all taken from these Museums.

For the embryological portion of my work I attended the department of anatomy of the Calcutta Medical College where a large collection of foetal feet was placed at my disposal. The sagittal sections of the small foetuses were made in the Pathological department of the same Institution.

The procedure of work that I have undertaken is not absolutely new. Some work from the embryological aspects on the same problem has been done by Bruce and Walmsley in 1938 and reference is made to a similar procedure by Lake (1935). Much work on the evolutionary trend of the human foot has been done by Morton, Weidenrich, Keith, Davenport, and Wood jones. The clinical portion of my work is unorthodox and I have combined the evidences and the deductions obtained from each of these three different directions to arrive at a conclusion as regards the veracity of one or other of these two different opinions about the longitudinal arch of the foot that I have enumerated.

### Reviews of Literature

*A. Views of those favouring the idea of a permanent structural arch depending upon bony configuration and ligamentous support.*

Clarke (1921) examined 100 consecutive cases of flat foot and came to the conclusion that in the majority of the cases, the falling of the arch, is due to the abnormal configuration of the constituents of the tarsal bones. A similar opinion is also held by Novojosserand (1923) who held that bony displacements are a marked feature of the majority of cases of flat foot, especially changes in the direction and shape of the astragalus and fusion and obliteration of the calcaneo scaphoid joint. Calcaneo scaphoid fusion as a cause of flat foot is also mentioned by Seddon (1933), who says, that it is a congenital abnormality and occurs in 25% of cases.

Morton (1924) from the researches on the evolution of the human foot came to the conclusion that the longitudinal arch is a new and distinctively human creation produced as the result of his early terrestrial habits, erect posture and increase of body weight. The most important factor in the causation of this new creation is the development of the heel as the result of increased leverage effort. The anthropoid apes such as the gibbon, the chimpanzee, the orang and the gorilla, as will be seen

later on, do not show the presence of the same arching of the foot. They have retained their arboreal habits for a much longer period and have only recently become terrestrial. Therefore the longitudinal arch which is an expression of grace and economy of effort in terrestrial locomotion has not had time or the opportunity to become developed in them. Reference will be made to the same subject in a subsequent chapter.

In a subsequent contribution (1925) Morton, from his staticometer study, which is an instrument designed to detect the amount of strain in the different segments of the foot when bearing weight, concluded that the rigidity and the integrity of the arch did not depend on the muscles. He says that the ligaments are uniquely adapted for the continuous and prolonged strain of static stresses in stance. The brief and violent strain in the stresses of locomotion is counteracted by the contraction of the muscles as it is in accord with the known physiologic properties of muscles. In normal stance the function of the muscles is merely to balance the leg bones on the feet.

Dunn (1928) says that in the longitudinal arch, the stress of body weight is for the most part borne by the ligaments—the tendons and muscles being only accessories. The height of the arch is a non-entity in the reaction of the arch to stress.

Lagomarsino (1930) is of opinion that the arch of the foot is maintained by its peculiar bony structure and ligamentous support. When it is actively used, the arch is also partially supported by the muscles but when it bears the weight of the body in standing, the ligaments bear almost all the strain. The arches are thus slightly depressed because of the elasticity of the ligaments and fasciae.

Henderson (1933) called attention to the disagreement over the relative importance of the muscles and the ligaments in support of the arch and thought it probable that the ligaments are becoming of increasing importance.

Whitman says that when the foot serves as a passive support the ligaments bear the greater part of the strain and their normal elasticity allows the bearing surface to expand as the arches are slightly depressed. During active locomotion the ligaments are helped by the contractural force of the muscles.

Norman Lake (1935) is the most ardent supporter of the theory of a structural arch. According to him the chief factor in the production and maintenance of the arch is the conformation of the bones and the factor next in order of importance is the plantar ligaments of the foot. The plantar fasciae and the short muscles of the sole are subsidiary factors which also help. The calf muscles—ordinarily of no help—by their contractural force in certain phases of locomotion, especially when the heel is off the ground, take some of the strain and thus are also of use.

Lake makes the following further observation—"The postural tone of the muscles is anti-gravity not in the sense that it is responsible for resisting the whole effect of the gravitation, but it regulates mobility of joints in the weight-supporting skeleton. For example, in the knee joint, the bones support the weight: the function of the postural tone of the quadriceps is to balance the femur on the tibia, so that the weight is transferred directly through the longitudinal axis. The application of this idea to the support of the arch of the foot is an unwarranted extension due to mis-conception. Here we are dealing with a question of dead weight and not with the delicate balance of one bone upon another. Ligaments are used for support of super-incumbent weight in joints where little mobility is possible, viz. sacroiliac joint. The function of the postural tone of the muscles is to balance the leg upon the foot."

Bruce and Walmsley (1938) examined the feet of a large collection of foetuses from the 40 mm., i.e., 10 weeks stage. Their conclusions were that by the end of the 3rd month of foetal life, the foot is already arched in a

manner closely resembling the arching of the normal adult foot. The modification which the bones undergo in the later part of foetal life and infancy and the changes which these modifications produce on the arches are imposed on a skeletal form which is primarily an arched one. They also opine that the apparent non-development of the arch in the foetus and the new-born is probably accounted for by the inverted position of the foot and the plantar pad of fat which is present here at this time and hides the arches.

Clifford James (1939) carried an investigation by obtaining the foot prints of 65 natives of Solomon Islands who do not wear shoes and compared them with those of 5 Europeans. Their conclusions were as follows:—The longitudinal arch exists in both European and native races and is a definite structural feature of the anatomy. Though it can be increased by muscular action, it cannot be flattened either voluntarily or passively even under an anaesthetic by manipulation with hands.

R. L. Jones (1941) made a detailed experimental study with the muscles of the foot especially the long leg muscles. His conclusion were as follows:—

(1) The posterior tibial and peroneus longus are relatively unimportant as plantar flexors bearing only 5% of the total tension stress.

(2) Of the total tension stress of the longitudinal arch, not more than 15 to 20% is borne by the deep posterior tibial and peroneal muscles. It is unlikely therefore that these muscles will be responsible for the maintenance of the arch.

(3) Much the greater part of the tension stress of the longitudinal arch is borne by the plantar ligaments of the foot. The short plantar muscles also contribute to the support of the arch.

(4) Distress or failure in the human longitudinal arch is correlated not with the absolute value of the stress on the arch but with the temporal duration of the stress.

(5) A fallen or flattened arch cannot be raised by muscular exercise.

(6) An important and perhaps the chief function of the so called invertor and evertor muscles is to preserve a relative constancy in the ratio of weight distribution among the metatarsals of the foot, compensating reflexly for intrinsic and extrinsic factors which alter that ratio.

It may be noted that this conception of the function of the invertor and evertor muscles is different from that of Morton (1935) who assigned to them the important function of balancing the leg upon the foot as a stable base.

*B. Views of those favouring the idea of a postural arch depending mainly upon the postural tone of the muscles.*

Lovett (1916) studied the feet of 800 nurses and came to the conclusion that the lowering of the arch was due to muscular strain.

Keppler (1917) says that the wasting and atrophy of the muscles is the cause of weakness of the foot with or without lowering of the arch. The most important cause of this atrophy of the muscles in civilized races, he says, is due to their being squeezed by rigid shoes. "It is also due to our unnatural walk with high heels, in which the toes are turned outwards and greatly increased strain is put under the innerside of the foot structure."

Crandon (1919) is of opinion that the weak, flat or pronated foot should be treated as a physiological and not as an anatomical entity. He says, "From the practical side of function and treatment, the human foot has no more a fixed arch than the extended hand until the muscles make one. Substitute the phrase "arching of the foot" for "arches of the foot" and the mental attitude towards the feet changes."

Cotton (1920) says that in cases of so called flat foot, there is no real deformity, merely a position of relaxation into pronation which may be corrected. This habitual pronation is due to weakness of the



muscles and must be treated along physiological lines. Changes in shoes and heels and insertion of pads will give comfort but a radical cure can only be obtained by the education and exercise of muscles.

Scheimberg (1920) says that the cause of weak feet in the child is reduction of postural tone and is associated with round shoulders, protruding abdomen, clumsiness in action and frequent falling. In the treatment, no operation is necessary nor plaster of Paris or adhesive plaster to hold the foot in supination. Successful treatment demands attention to attitude, foot gear and exercise.

Roberts (1920)—According to him the three common factors in the etiology of weak foot are, improperly designed foot, unequal development of leg muscles and deviation of the normal mechanical relations between the tarsus and the leg. He emphasizes the advantages of muscle training.

Fairweather (1926) in discussing the effects of continual use of high heeled shoes says that it is the muscles which pass under the plantar calcaneo-navicular ligament that are mainly responsible for the maintenance of the arch. The foot is considered as a weight-bearing tripod resting on the heel, first metatarso-phalangeal joint and the whole of the fifth metatarsal bone. When the heel is raised as in wearing high heel shoes, the strain falls more on the antero-internal tripod. Nature provides some compensation for the longitudinal arch as the muscles under the internal malleoli become straightened and can therefore pull with mechanical advantage but if one has to do long periods of standing in high heels or due to the effects of illness, the muscles get tired and atrophied and the ligaments and fasciae being unable to sustain the arch, it begins to give way and foot strain occurs.

Rossmith (1928) thought it erroneous that the arches of the foot are supported by ligaments. In the foot, as elsewhere, the purpose of ligaments is to hold the articulating bones in apposition and to check momentarily excessive movement. Being

inelastic, the ligaments cannot withstand continuous strain under which they soon stretch. The maintenance of the arches when weight bearing depends normally on the long and short muscles of the foot. During standing the body weight tends to dorsiflex and pronate the feet. Accordingly those muscles which can resist dorsiflexion and balance the foot in mid-position between pronation and supination are found to be tonically contracted. They are triceps, the long leg muscles and the peronei. The long peroneus also supports the inner part by holding the great toe firmly against the ground. The lumbricals, the interossei, the abductor hallucis and the short muscles are also tonically contracted and help the arches.

Cyriax (1930) was of opinion that flat foot could only be corrected by strengthening the weakened muscles through a process of muscular re-education.

Anapol (1929) made the suggestion that the tibialis anterior is very important and when it fails, flat foot results.

Gottlieb (1932) called attention to the antagonism between the triceps surae muscle which he stated contributed to the flattening of the longitudinal arch and short plantar muscles which contributed to its retention.

Forester Brown (1932) says that the muscles which maintain the normal position of slight inversion in weight bearing are the tibialis posticus and anticus. If their functions are lost, no mechanical adjustments of the foot can restore the normal balance.

Keith (1933) from his study of the evolutionary history of foot muscles came to the conclusion that the muscles originally subserving prehension in pronograde animals take over a new function in stabilising the foot when applied to the ground and in producing and maintaining the arches of the feet. Nature, he says, never uses ligaments as prime supporters in the structure of the animal body. Always muscles are used for this purpose. Ligaments only act as safe-

guards, coming into action when muscular defence has broken down. In support of his contention that the main support of the longitudinal arch are the muscles, Keith recalls the fact that many muscles of the feet which in pronograde animals were subserving prehension find new attachments and alter their line of action to perform this new function of the maintenance of the arch to their best advantage. These muscles are :—

(1) The plantaris—in the pronograde animals is was prolonged into the sole but in man the growth of the “anthropomorphic” heel separates the tendon of the plantaris from its prolongation into the sole—the middle part of the plantar fascia, which assists in maintaining the arch.

(2) The flexor brevis digitorum which, in lower primates, arises principally from the long flexor tendons has its origin completely transferred to the os calcis in man and can thus act more powerfully in supporting the arch.

(3) The flexor accessorius—a detached part of the flexor longus hallucis is specially well developed in man and helps to maintain the arch.

(4) The tibialis posticus, originally a flexor of the metatarsus corresponding to the flexor carpi radialis of the hand, obtains a secondary attachment to the scaphoid in man.

(5) The tibialis anticus which corresponds to the extensor osis metacarpi pollicis of the hand becomes permanently inserted into the internal cunieform. Both of these muscles help to maintain the arch of the foot.

Wiles (1934) says that the function of the ligaments is to check extremes of movements. They do not play any direct part in the maintenance of posture and no continuous strain falls on them. It is the muscles that hold the joints in position and only when they fail are the ligaments placed under strain. The posture of the foot including the height of the arch depends on

the position of the intrinsic joints. The body weight is transmitted from bone to bone just as it is from femur to tibia. The position of the joint is altered by active muscular contraction and maintained by the tone of the posturing muscles as it is everywhere else in the body. Further, in reply to one of Lake's articles in the *Lancet* (1937), Wiles adds that the normal foot is a moderately supple structure, permitting movement at the sub-astragaloid and astragaloscaphoid joints. These change the height of the arch which therefore depends on the position of the sub-astragaloid joints. Ligaments could only play an important part in the integrity of the arch if it was fixed in height like a masonry arch. If the arch can really be raised and lowered at will, which he thinks could be done, the ligaments cannot behave in such a way because they have not the necessary elasticity.

Bankart (1935) is the chief exponent of this theory. According to him the function of the ligaments is not to withstand continuous strain. This is always the function of the muscles. The correct attitude of the feet in standing is maintained by the postural tone of the long leg muscles and it is but a part of the general postural reflex which maintains the upright position of the body as a whole. The arch of the foot then is not a fixed or constant structure but it is an attitude produced and maintained by muscular action. When they relax the arch sinks. The natural foot should be so supple that it can be completely flattened or raised into the form of an arch at will. The permanent arch seen in the feet of civilised people is due to the restrictions put on it by foot wear. Foot strain occurs when due to some cause the postural tone of the muscles becomes diminished and the other soft tissues are made to withstand the strain of weight bearing. In reply to the findings of Bruce and Walmsley already referred to, that the arches of the foot are present even from early foetal stage, Bankart shifted his ground somewhat and made the suggestion that when a joint or series of joints has a wide range of normal movement, one would

expect its anatomy to be disposed about an intermediate position and not to be adopted to one of its extremes. The normal foot at rest and free from weight bearing falls naturally into a position in which there is a moderate longitudinal arch. It is the fixation of this arch and consequent inability of the foot to yield without encountering resistance and strain that was regarded as unnatural.

Lange (1935) thought that lowering of the arch and flatness of feet was the result atrophy of muscles by constant wearing of hard narrow shoes. These practises have resulted in familial constitutional weakness of the feet.

Kaplan & Kaplan (1935) from their study of the arches of the foot were of opinion that the long leg muscles played a major part in the support of the longitudinal arch. The muscles weakened by fatigue or other causes become unable to support body weight thus throwing an unaccustomed burden on ligaments, which give way and flat foot results.

Wiltz (1935) removed the muscles and exposed the tendons of the posterior tibial, flexor longus digitorum, peroneus longus, tibialis anterior and flexor longus hallucis. To each tendon he attached rubber bands which exerted pull of 5 lbs. tension. He then determined the load which when applied on the vertical tibia was necessary to depress the talo-navicular and calcaneocuboid joints. He then freed the respective muscle's tendon from the 5 lbs. tension and again determined the load necessary to depress the above mentioned joints. From data thus obtained he concluded that there were 2 means of support of the longitudinal arch—a direct upward pull as exhibited by the tibialis anterior and peroneus brevis and a lift from below as shown by the long plantar muscles which is increased by mechanical advantage of pulleys and tendons.

Mercer (1936) says that variations in the height of the arch are achieved by

alteration in the position of the talo-navicular joints induced by contraction and relaxation of the tibial muscles. The reason for flatness of the foot on weight bearing in the child is the non-development of the postural tone of the long muscles which is a late human development. In the foot of the orthograde primate animals, the tibial muscles are concerned only with active movements of locomotion and have no postural activity. Should they fail to develop in man, the arches are flattened by weight bearing.

In favour of Bankart's contention that the rigid arches of the human foot are really contractural deformities produced by habitual use of foot wear is the evidence of Miltner (1937) in China, who examined a large number of bound feet. The Chinese women are accustomed to practice rigid restrictions on the growth of their feet by binding them with stiff cloth or other materials. This results in increase of the height of the arch, the os calcis becomes vertical—the metatarsals are flexed and the muscles and ligaments are shortened and atrophied.

Schawrtz & Heath (1937) by examination of a large number of feet deduced that the weight bearing axis of the leg is normally situated inside the weight bearing axis of the os calcis. There is therefore a natural tendency to pronation in normal feet which is counter-balanced not by ligaments but by the long muscles which latter are necessarily responsible for the maintenance of the arches.

Ernst & Fisher (1937) said that the foot is held in its normal plantigrade position by the supinators. Weakness of these supinators cause laxity of the tarso-metatarsal joints and flattening of the longitudinal arch.

Bettmann (1937) advocated the strengthening of the lifting muscles of the inner border and the transverse portion of the arch with the idea that if the foot muscles were of normal tone and functioned properly they would prevent the painful lowering of the arch.

Higgs (1937) agreed with Bankart that the normal arch is maintained by the muscles—that the ligaments are not designed to sustain weight. According to him also the normal human arch should be so supple that the arch can be raised or flattened at will.

Lambrinudi (1938) ascribes to the long muscles the important function of originating and maintaining the arches.

### The effects of footwear on the longitudinal arch of the foot

During the course of my clinical investigations I examined the feet of about 400 people. The best method of obtaining a permanent record of the arch under the different circumstances was considered and it was decided to obtain foot prints for the purpose by making the persons stand on a square piece of paper and putting on his body weight evenly on both feet. In those cases in which the persons were unable to stand, the print was obtained by spreading the paper on a piece of flat hard wooden board and pressing this against his feet. At the same time the knees were bent to a right angle and the person was asked to press against the board with all the force he was capable of. In some cases he was assisted in doing so. In all cases printers ink was used to smear the sole of the feet. The prints so obtained are modelled feet examined and when they are compared in a large series of cases, their value is enhanced. At the same time the persons were questioned as regards any abnormality or complaint about their feet; structural abnormality if any was noted and the height of the arch was measured, when required, being the distance from the ground to the tuberosity of the navicular bone (Davenport).

For comparing these prints from the point of view of weakness of the feet and lowering of the arch two different measurements were taken wherever necessary. One is the foot print line described by Leebivings

(1933) Fig. I. This is a line which passes through the centre of the heel (A) and another point (B) which is at the centre of a line drawn at  $\frac{1}{4}$  the distance from the heel to the great toe.

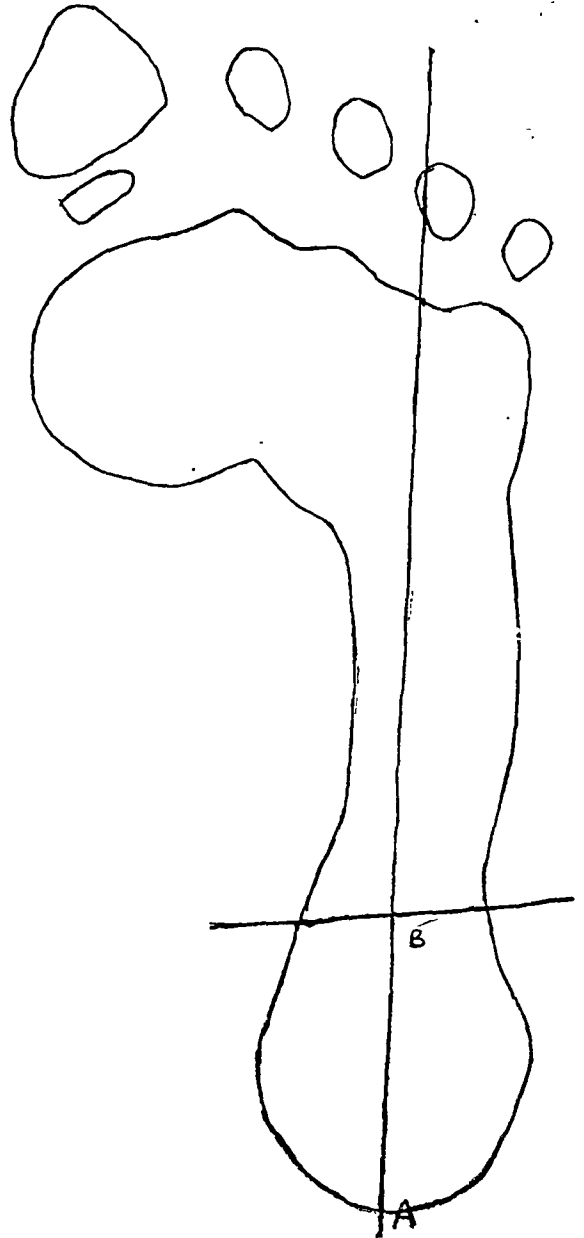


Fig. 1.  
Leebivings Foot-print Line.

This point is supposed to be at the junction of the astragalo-scapoid and calcaneocuboid joints and the fore part of the foot which is relatively mobile abducts from the posterior fixed portion at this junction. This

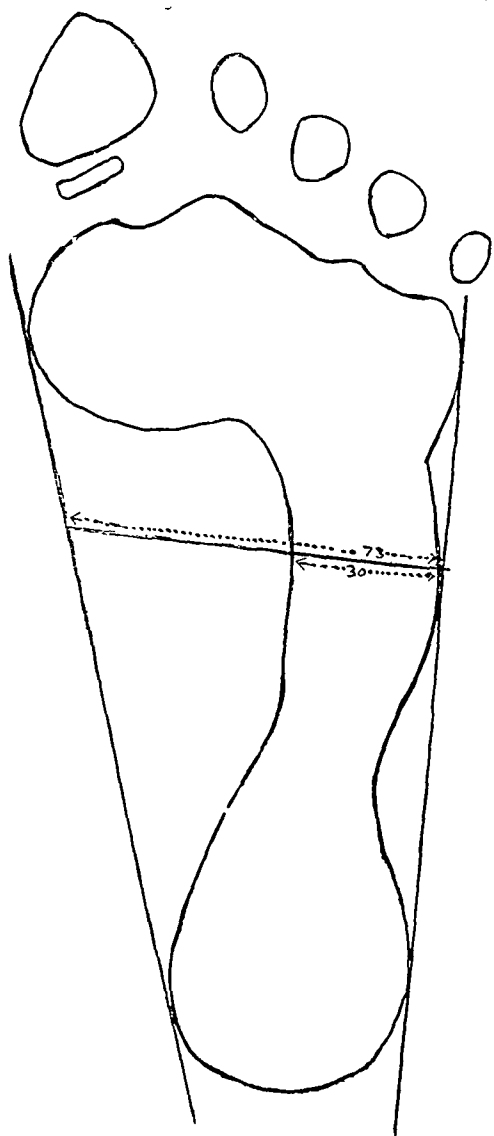


Fig. 2.  
Arch Fraction.

abduction of the forepart of the foot is usually associated with eversion of the foot and falling of the arch and is considered by Leebivings to be an indication of the weakness of the foot. This line prolonged forwards cuts one of the toes or passes between two adjacent toes. According to Leebivings, in a normal foot, it should cut the fifth toe or pass just outside it. In the first degree

of weakness of the foot, the line passes from between the middle of the fifth to the middle of the fourth toe. In the second degree of weakness the line passes from between the middle of the fourth to the middle of the third toe. In the third degree of weakness it is between the middle of the third to the middle of the second toe and in the fourth degree of weakness, which corresponds to a completely flattened foot, it is inside the middle of the second toe. The more abduction of the foot there is, the more the line passes inwards and the more weak the foot is supposed to be. (Fig. 1).

Another transverse line is drawn through a point at the middle of the distance between the heel and the great toe. The portion of this line included between the two lines joining the two sides of the heel and the balls of the great and little toes is arbitrarily taken to be the average breadth of the foot. The area of the foot print that comes in contact with this line is determined by the height of the longitudinal arch. The higher the arch the less would be the area that would come in contact with this line, and the lower the arch the more would be the area that would touch this line. Therefore the fraction of the area of the foot that touches this line to the average breadth of the foot as determined before, is an approximate indication of the height of the arch. This was determined in each instance and will subsequently be called the arch fraction of the foot. (Fig. 2.)

In order to determine the difference if any as regards the longitudinal arch between habitually bare-footed people and those who use rigid foot wear all the time I made a series of investigations. Fifty prints were obtained of those people who have never worn shoes and therefore have allowed their feet natural development. (Table I). Twenty seven were menial servants of the hospital and 13 were odd people who did all sorts of work, labourers, handcart pullers, mechanics, etc. Of these 42 prints were photographed (Fig. 3.). These are the people, in whom according to

TABLE I  
BARE-FOOTED PEOPLE

Name	Age	Occupation	Arch Fraction		Degree of Weakness	
1. Paramananda	20	Coolie S.N.P.H.	Rt = .80	Lt = .36	Rt = 2D	Lt = 2D
2. Jilmil	60	Methar	Rt = .51	Lt = .54	Rt = 2D	Lt = 1D
3. Sk. Kunai	40	"	Rt = .41	Lt = .46	Rt = 1D	Lt = 1D
4. Jangal	35	Coolie	Rt = .50	Lt = .52	Rt = 2D	Lt = 1D
5. Bhuran	30	Methar	Rt = .44	Lt = .47	Rt = 2D	Lt = 2D
6. Hansa Raj	17	"	Rt = .33	Lt = .48	Rt = 2D	Lt = 2D
7. Chandradeo	28	Durwan	Rt = .30	Lt = .29	Rt = 2D	Lt = 2D
8. Musraff Husan	21	Coolie	Rt = .41	Lt = .43	Rt = 2D	Lt = 3D
9. Askrit Ram	30	"	Rt = .43	Lt = .46	Rt = 3D	Lt = 2D
10. Babar	40	Methar	Rt = .36	Lt = .38	Rt = 2D	Lt = 2D
11. Jagur Husan	32	Coolie	Rt = .46	Lt = .51	Rt = 2D	Lt = 1D
12. Musali Ram	29	"	Rt = .37	Lt = .35	Rt = 2D	Lt = 2D
13. Ram Kamal	35	"	Rt = .29	Lt = .35	Rt = 2D	Lt = 3D
14. Nimula	25	"	Rt = .37	Lt = .33	Rt = 1D	Lt = 1D
15. Kalachand	25	"	Rt = .30	Lt = .26	Rt = 2D	Lt = 2D
16. Kudan	22	"	Rt = .35	Lt = .37	Rt = 1D	Lt = 2D
17. Kunai	26	"	Rt = .20	Lt = .30	Rt = 1D	Lt = 2D
18. Rambilas	28	"	Rt = .46	Lt = .45	Rt = 2D	Lt = 1D
19. Matilal	17	"	Rt = .40	Lt = .41	Rt = 2D	Lt = 1D
20. Sajiban	60	"	Rt = .25	Lt = .12	Rt = Normal	Lt = Normal
21. Raksit	29	"	Rt = .40	Lt = .32	Rt = 2D	Lt = 2D
22. Prasanna	21	War technician	Rt = .37	Lt = .42	Rt = 2D	Lt = 3D
23. Mahammad	55	Cook	Rt = .40	Lt = .32	Rt = 2D	Lt = 3D
24. Basan	36	Coolie S.N.P.H.	Rt = .53	Lt = .45	Rt = 2D	Lt = 3D
25. Dokhi	27	Methar	Rt = .35	Lt = .37	Rt = 1D	Lt = 1D
26. Sk. Bagal	35	"	Rt = .30	Lt = .30	Rt = 2D	Lt = 2D
27. Samaru	40	Coolie	Rt = .41	Lt = .37	Rt = 2D	Lt = 3D
28. Makbul	30	Labourer	Rt = .37	Lt = .41	Rt = 2D	Lt = 2D
29. Rambarat Ram	50	Sardar S.N.P.H.	Rt = .37	Lt = .36	Rt = 2D	Lt = Normal
30. Sk. Amir	16	Coolie	Rt = .45	Lt = .45	Rt = 1D	Lt = 2D
31. Manmatha Das	31	Mechanic	Rt = .14	Lt = .40	Rt = 1D	Lt = 2D
32. Ismail	20	Methar	Rt = .47	Lt = .50	Rt = 1D	Lt = Normal
33. Rambilas	40	Coolie	Rt = .37	Lt = .42	Rt = 1D	Lt = 2D
34. Santa Lal	40	"	Rt = .69	Lt = .66	Rt = 3D	Lt = 3D
35. Kali Charan	19	Dome	Rt = .32	Lt = .21	Rt = 2D	Lt = 2D
36. Bhorai	22	Electric Mistry	Rt = 1	Lt = 1	Rt = 4D	Lt = 4D
37. Ramrup	25	Labourer	Rt = .31	Lt = .29	Rt = Normal	Lt = Normal
38. Jyoti Lal	20	Handcart Puller	Rt = .42	Lt = .36	Rt = 2D	Lt = 2D
39. Tangai	30	Labourer	Rt = .38	Lt = .42	Rt = 2D	Lt = 2D
40. Akbar Ali	40	"	Rt = .36	Lt = .43	Rt = 1D	Lt = 2D
41. Ghura Ram	42	Coolie S.N.P.H.	Rt = .55	Lt = .63	Rt = 2D	Lt = 2D
42. Bangali Ram	30	"	Rt = .67	Lt = .67	Rt = 1D	Lt = 1D
43. Durjan	36	"	Rt = .72	Lt = .46	Rt = 3D	Lt = 2D
44. Sakur	40	Methar	Rt = .54	Lt = .47	Rt = 3D	Lt = 3D
45. Chandradip	54	Coolie	Rt = .51	Lt = .55	Rt = 1D	Lt = 1D
46. Ramu Ram	32	"	Rt = .46	Lt = .58	Rt = 2D	Lt = 2D
47. Md. Razak	23	Methar	Rt = .77	Lt = .89	Rt = 2D	Lt = 2D
48. Kaloo	35	Coolie	Rt = .75	Lt = .45	Rt = 3D	Lt = 3D
49. Mamtaz	25	"	Rt = .39	Lt = .38	Rt = 1D	Lt = 1D
50. Bhupati	45	Labourer	Rt = .40	Lt = .34	Rt = 2D	Lt = 2D

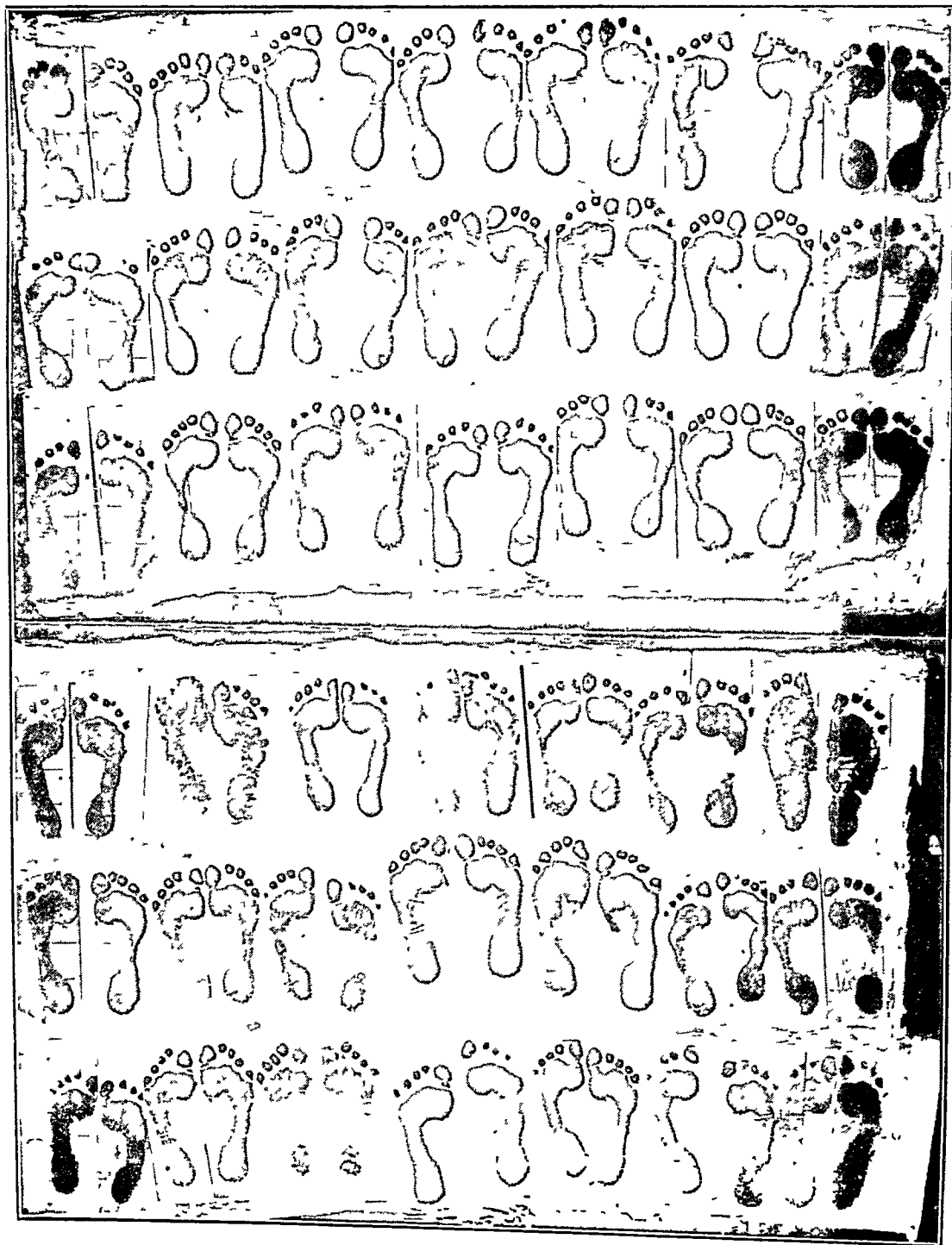


Fig 3  
Foot-prints of bare-footed people.

Bankart, Wiles, Higgs and others, the arch should have been so supple, as to be capable of being raised and flattened at will. Let us quote Bankart's exact words. "The truth is that the natural feet as seen in the bare-foot races, who have never worn boots or shoes is completely flat, when the muscles are relaxed and are arched only when the muscles are in action. You may observe the same thing in the feet of ballet dancers—their feet are completely flat, when standing at ease and are highly arched, when the muscles are in action. You may observe the same thing in the feet of your own children when they are beginning to walk."

My observations were entirely contrary to the above statement. I found that these bare-footed people had well developed arches which were fixed structures and not capable of being altered at will except for the very slight lowering that took place when standing with the full body weight on the feet. The feet were far from supple, they were rigid and in-elastic and there was little or no difference between such feet and of those who habitually wear shoes, as far as the rigidity was concerned. The rigidity of the adult human foot and its fixed arch is not therefore the result of the use of foot wear but is due to some other cause. The same opinion is held by Clifford James (1939) who carried out an investigation amongst the natives of the Solomon Islands. His conclusion is that the longitudinal arch exists in the feet of both European and Native races and is a definite part of the anatomy. Though it can be increased by muscular action it cannot be flattened either voluntarily or passively even under an anaesthetic by manipulation with hands. He administered an anaesthetic to a normal native selected only because of his willingness to co-operate. When he was deeply under, a print was taken of his flaccid feet; pressure being applied with all the force that could be exerted. Comparison of the print of his flaccid feet with those of his feet under normal circumstances revealed no difference. The same conclusion was arrived

at by Thompson (quoted by Lake) after examining the prints of the natives in the African Tropical Zones. He noted well developed arches among some of the tribes and amongst others the arches were low and therefore the differences were not the results of restrictions of foot wear but were racial. Among the foot-prints of these 50 bare-footed people in my series there was one (Bhorai No. 36, No. 28, Fig. III) who had congenital flat feet. He acknowledged to having this flatness from his childhood, had no pain or complaints about his feet and was a hardworking individual being the electric mistry of the hospital. As his case belongs to a different category, he will not be considered in making the calculations and deductions. The rest of the 99 feet had well developed arches and the foot print line in the majority of the cases passed between the 5th, 4th or 3rd toes—that is, the 1st and 2nd degree of weakness of the feet were the commonest. The most prominent arch was in the left foot of No. 20 where the arch fraction was .125 (No. 8—Fig. 3) whereas the lowest arch was in the right foot of number 1, where the fraction was .80 (No. 23—Fig. 3). The average arch fraction of these cases was .374. Following Leebivings classification:—

"Normal" feet were seen in	..	6.2%
1st degree of weakness was seen in	..	28.7%
2nd degree of weakness	..	53.7%
3rd degree of weakness	..	10.2%
4th degree of weakness	..	Nil.

It will be seen that according to Leebivings standard the greatest number of "natural" feet fall under the category of the second degree of weakness and the percentage of so-called normal feet is only 6. It will be unjustified therefore to stick rigidly to this classification and regard all feet whose foot-print line passes inside the little toe as abnormal since it does so in more than 50% of apparently normal cases. We might say therefore that all feet whose foot print line passes outside the middle of the 3rd toe are within normal limits and the real weakness of the foot begins when the line is deflected still more medially.



TABLE II

Name	Age	Occupation	Arch Fraction		Degree of Weakness	
			Rt	Lt	Rt = 1D	Lt = 2D
1. Gadadhar Das	21	Male Nurse, S.N.P.H.	Rt = .51	Lt = .46	Rt = Normal	Lt = Normal
2. S. Chakravarty	26	" "	Rt = .39	Lt = .60	Rt = Normal	Lt = Normal
3. S. N. Chatterji	24	" "	Rt = .48	Lt = .34	Rt = 4D	Lt = 4D
4. P. C. Chatterji	26	" "	Rt = .86	Lt = .49	Rt = 3D	Lt = 3D
5. Md. Ali	24	" "	Rt = .49	Lt = .40	Rt = 3D	Lt = 3D
6. Dr. Guha	26	H.S.	Rt = .74	Lt = .62	Rt = 3D	Lt = 3D
7. Dr. D. N. Sen	57	Pathologist	Rt = .42	Lt = .43	Rt = 3D	Lt = 3D
8. Dr. Mitra	27	H.S.	Rt = .46	Lt = .46	Rt = 1D	Lt = 2D
9. Dr. R. Das	32	H.S. Seva Sadan	Rt = .48	Lt = .57	Rt = 2D	Lt = 2D
10. Dr. G. C. Chakravarty	28	H.S. S.N.P.H.	Rt = .35	Lt = .42	Rt = 1D	Lt = 1D
11. Dr. D. N. Ghosh	27	H.S.	Rt = .45	Lt = .46	Rt = 1D	Lt = 2D
12. Dr. S. N. Chatterjee	26	H.S.	Rt = .83	Lt = .83	Rt = 2D	Lt = 2D
13. Dr. R. N. Chatterjee	35	H.S. Seva Sadan	Rt = .42	Lt = .34	Rt = 2D	Lt = 3D
14. Dr. A. Das	26	H.S. Car. M. C. Hosp.	Rt = .51	Lt = .41	Rt = 2D	Lt = 3D
15. Dr. G. Ghosh	26	H.S.	Rt = .33	Lt = .33	Rt = 2D	Lt = 2D
16. Dr. Kumar	32	H.S. S.N.P.H.	Rt = .75	Lt = .74	Rt = 1D	Lt = 2D
17. Sakali Sarma	22	Compounder S.N.P.H.	Rt = .95	Lt = .47	Rt = 4D	Lt = 3D
18. Dr. Chanda	27	H.S. S.N.P.H.	Rt = .47	Lt = .48	Rt = 2D	Lt = 2D
19. Dr. Maitra	35	H.S. Car. M. C. Hosp.	Rt = .88	Lt = .95	Rt = 3D	Lt = 1D
20. Dr. B. Mukherji	37	H.S. S.N.P.H.	Rt = .88	Lt = .95	Rt = 3D	Lt = 3D
21. Dr. L. M. Sen	55	Anaesthetist, S.N.P.H.	Rt = .50	Lt = .56	Rt = 1D	Lt = 2D
22. Dr. D. Chatterji	28	H.S. Car. M. C. Hosp.	Rt = .36	Lt = .37	Rt = 3D	Lt = 1D
23. Dr. Neogy	32	H.S.	Rt = .46	Lt = .42	Rt = 2D	Lt = 3D
24. Dr. Ganguly	25	H.S. Seva Sadan	Rt = .94	Lt = .49	Rt = 4D	Lt = 3D
25. Dr. Ghosh	26	H.S. S.N.P.H.	Rt = .91	Lt = .94	Rt = 4D	Lt = 4D
26. Dr. M. Samanta	25	H.S. Car. M. C. Hosp.	Rt = .46	Lt = .45	Rt = 2D	Lt = 2D
27. Dr. A. N. Maitra	29	H.S.	Rt = .44	Lt = .32	Rt = 1D	Lt = 1D
28. Dr. Guin	29	H.S. P.G.H.	Rt = .46	Lt = .47	Rt = 2D	Lt = 1D
29. Dr. K. Alam	33	H.S.	Rt = .56	Lt = .45	Rt = 2D	Lt = 2D
30. Dr. J. Bose	25	H.S. Car. M. C. Hosp.	Rt = .37	Lt = .32	Rt = 1D	Lt = 1D
31. Dr. S. Dutt	27	H.S.	Rt = .46	Lt = .49	Rt = 2D	Lt = 2D
32. Dr. M. Adhikari	26	H.S.	Rt = .49	Lt = .51	Rt = 1D	Lt = 2D
33. Dr. D. Kundu	28	H.S.	Rt = .47	Lt = .52	Rt = 2D	Lt = 3D
34. Dr. A. Roy Chowdhuri	25	H.S.	Rt = .39	Lt = .50	Rt = 2D	Lt = 2D
35. Dr. S. Bose	28	H.S.	Rt = .38	Lt = .38	Rt = 1D	Lt = 1D
36. Dr. G. Mondol	26	H.S.	Rt = .52	Lt = .40	Rt = 2D	Lt = 2D
37. Dr. S. Chowdhury	27	H.S.	Rt = .46	Lt = .46	Rt = 2D	Lt = 2D
38. Dr. A. Roy	27	H.S.	Rt = .50	Lt = .40	Rt = 3D	Lt = 3D
39. Dr. A. Mitra	27	H.S.	Rt = .33	Lt = .35	Rt = 2D	Lt = 2D
40. Dr. D. Banerji	28	H.S.	Rt = .40	Lt = .47	Rt = 2D	Lt = 2D
41. Dr. R. Dutt	25	H.S.	Rt = .47	Lt = .47	Rt = 2D	Lt = 2D
42. Dr. S. Bose	26	H.S.	Rt = .41	Lt = .36	Rt = 2D	Lt = 2D
43. Dr. N. Mukherjee	28	H.S. P.G.H.	Rt = .93	Lt = .63	Rt = 4D	Lt = 2D
44. Dr. Bhattacharjee	27	H.S. Seva Sadan	Rt = .40	Lt = .40	Rt = 2D	Lt = 3D
45. Rabbani	33	Compounder S.N.P.H.	Rt = .40	Lt = .52	Rt = 1D	Lt = 1D
46. Sudarsan Dutt	24	Male Nurse, S.N.P.H.	Rt = .50	Lt = .48	Rt = 1D	Lt = 1D
47. S. K. Bose	28	" "	Rt = .48	Lt = .51	Rt = 3D	Lt = 3D
48. G. A. Rahaman	25	" "	Rt = .85	Lt = .80	Rt = 2D	Lt = 2D
49. Dr. Basu	30	R.S. S.N.P.H.	Rt = .50	Lt = .63	Rt = 1D	Lt = 3D
50. S. Ahmed	21	Male Nurse, S.N.P.H.	Rt = .62	Lt = .50	Rt = 3D	Lt = 3D

The next series was of 50 people who habitually wear shoes. Hospital doctors were considered to be the best subjects for this series of investigation because they are

the people who continually wear shoes and are on their feet for long periods of time (Table II). Along with them were included a few male nurses and compounders who

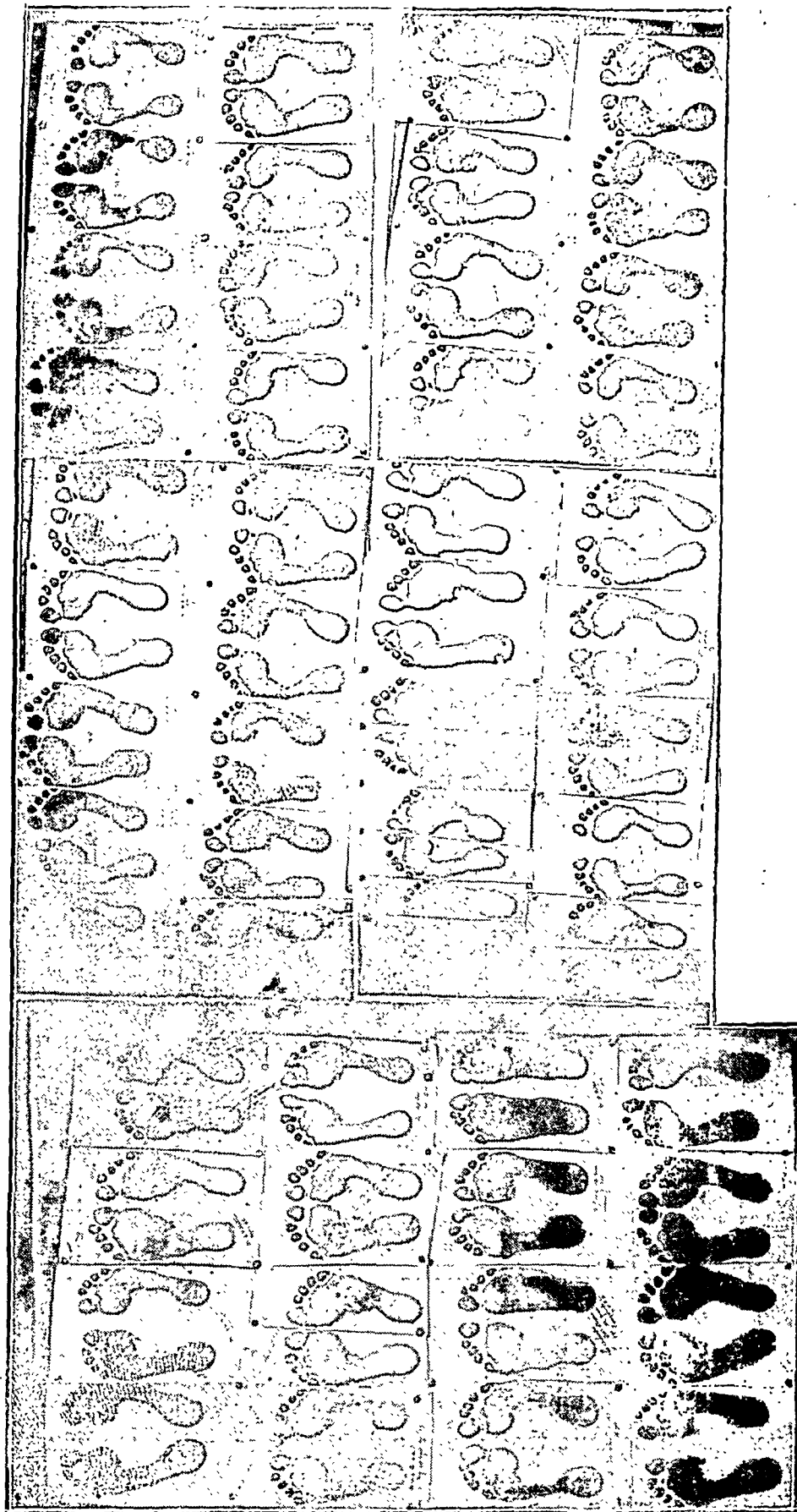


Fig. 4.  
Foot-prints of people who continually wear shoes.

also did long periods of walking and standing with shoes on. The doctors were mostly housemen belonging to the Sambhunath Pandit Hospital, Presidency General Hospital and Carmichael Medical College Hospitals. In their cases (Fig. 4) the most prominent arch and the lowest arch fraction was in the left foot of number 30 where the arch fraction was .32 and the lowest arch and the highest fraction—.95 was in the right foot of number 17. The average arch fraction was 0.523. In this series:—

Percentage of "normal" feet	..	0.96%
1st degree of the weakness	..	28.8%
2nd degree of the weakness	..	39.4%
3rd degree of the weakness	..	23.07%
4th degree of the weakness	..	4.8%

Comparison of these two series of foot prints reveals certain differences. It would be seen that the arch fraction is greater in people who wear shoes than amongst bare footed people, so that the height of the arch is lower amongst the former. This result is contrary to the suggestion that the permanent and rigid arch of the human foot is produced by restrictions of foot wear. It is also against the views of Robert Jones who says that in barefooted people there is a great development of the muscles of the foot so that the arch is masked. Other differences noted between these two sets of prints are as follows:—

(1) The percentage of so called "normal" feet is less amongst the booted people.

(2) There is increased percentage of 3rd and 4th degree of weakness amongst booted people.

These two findings and a review of the general configuration of the prints of the two series reveal that amongst people who habitually wear shoes the fore part of the foot is slightly abducted on the hind part.

An average print of a bare-footed person when super-imposed on an average print of the second series makes interesting study (Fig. 5). It would be seen that the average print of the bare-footed foot is of the shape

A in Fig. 5. The ball of the great toe makes a sharp angle with the "waist" of the foot. Also the toes are well spread out and radiate in straight lines from the heel. In an average print of the second series (B—Fig. 5) the fore part of the great toe

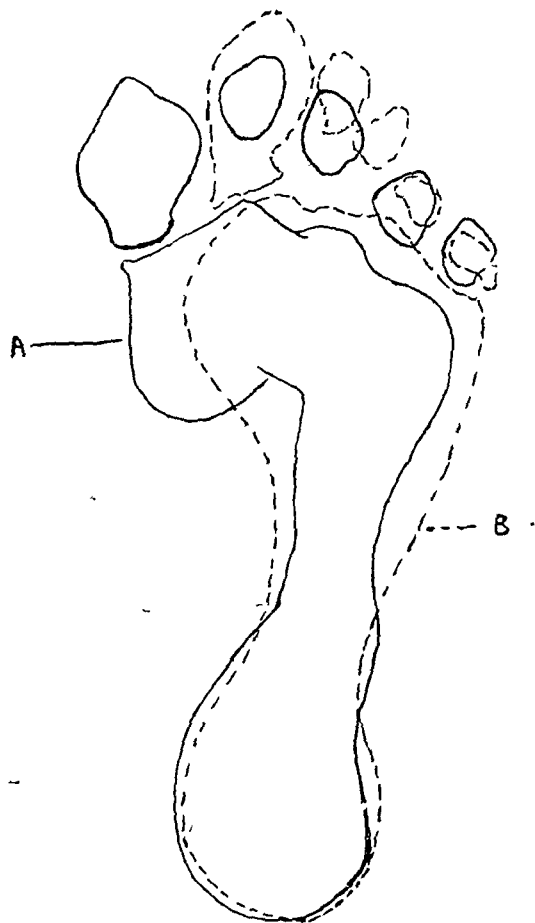


Fig. 5.

Foot-prints of Booted and Bare-footed people superimposed.

makes a larger angle with the "waist." Also the toes are more crowded together and especially the great toe, which is sharply abducted. The mechanism of the abduction of the fore part of the foot in booted people is thus explained by Lagomarsino. He says "the mechanism of flat or abducted foot consists in relaxation of the structures which maintain the longi-

tudinal arch especially the inferior calcaneo-scaphoid ligament upon which the head of the astragalus rests. As the ligament stretches the head of the astragalus becomes depressed and the anterior portion of the foot becomes abducted at the mid-tarsal joint."

That the rigid stockings used by civilised races also interfere with the natural development of the foot is emphasized by Schiemborg (1920). He says that in an ideal footwear, in addition to a properly fitted shoe which does not cause abduction of the great toe, the stocking should also be fitted with the same object in view. In weight bearing, the great toe naturally tends to abduct somewhat from its relaxed position because of the contraction of the flexor longus hallucis. Most stockings tend to prevent this abduction. The ideal stocking should have a separate hole for the great toe.

The abduction of the forepart of the foot in bare footed people is advantageous because it distributes the weight borne by the anterior two pillars of the longitudinal arch

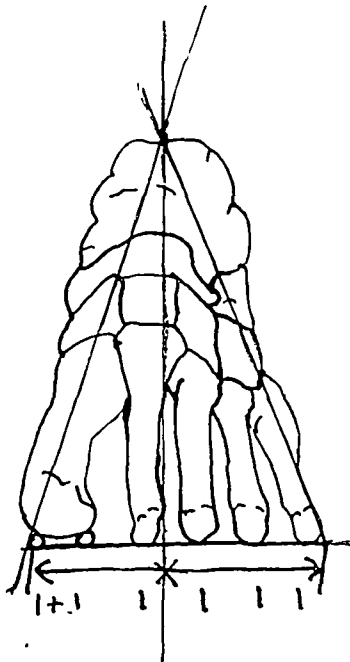


Fig. 6.

Weight distribution among metatarsal heads in normal foot during stance.

amongst all the metatarsal heads. According to Morton (1937), in normal stance, the axis of weight bearing falls between the second and the third metatarsal heads and the different metatarsals carry weight in the proportions of 2 : 1 : 1 : 1 : 1 (Fig. 6) the great toe because of its two sesamoid bones carries twice the amount borne by the other toes. Thus the foot consists of not one but five separate longitudinal arches united posteriorly in the heel. In a man weighing 144 lbs., when standing with weight equally distributed on both feet—each foot carries 72 lbs. of weight, which is distributed in the proportion of 36 lbs. to the heel, 12 lbs. to the great toe, and 6 lbs. to each of the other four toes. In locomotion, during the take off position of the

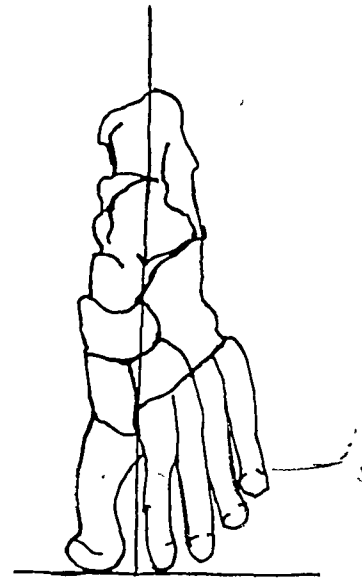


Fig. 7.

Weight distribution among the metatarsal heads during the "Take-off" position of locomotion.

foot (Fig. 7) only the first and second metatarsal of the heads come in contact with the ground and the amount of weight they carry is much increased. Here the axis of leverage passes between the 1st and 2nd metatarsal heads and the two bones act together as the fulcrum of leverage. During this period, the body weight is supported only on one foot because the other is swing-

ing forward into the advancing position. The 2 metatarsal heads carry therefore an enormous weight and the strain on the arch would be very much increased, were it not for the fact that the contractural force of the muscles takes off some of the strain from the bones and the ligaments.

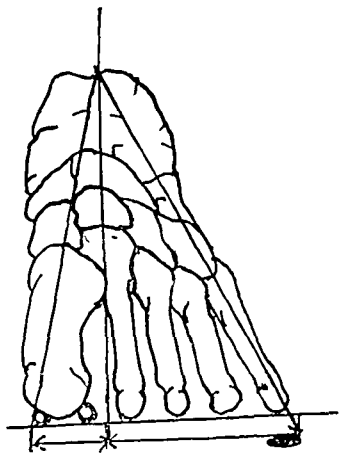


Fig. 8.

Weight distribution among metatarsal heads in Stance and in Abducted Foot.

The cumulative effect of the abduction of the forepart of the foot on the ratio of the distribution of weight among the five metatarsal heads is to make the head of the first metatarsal carry most of the strain and spare the other metatarsal heads—both during normal stance and in locomotion. In normal stance, the axis of weight bearing will pass closer to the first metatarsal or even through it, so that it alone will carry most of the weight (Fig. 8). In locomotion, similarly, the weight, instead of being distributed equally between the two metatarsal heads, is concentrated mainly on the first metatarsal.

In an adducted foot as in bare footed individuals the body weight is carried straight over the arch and over the strongest parts of the foot supported by strong ligaments. (A—Fig. 9). In an abducted foot as in booted people the same weight goes over the arch by climbing up

the outside of the posterior pillar, going over the summit diagonally from the back and then going down over the opposite side of the anterior pillar (B—Fig. 9). This is an obvious mechanical disadvantage because no arch is made to take the strain on the sides of the pillar and the ligaments and muscles being at an angle with the axis of weight bearing cannot support the arch to their best advantage. If the arch of the foot be considered as a tripod (as it is often done) resting on the three pillars, which are the heel, the head of 1st metatarsal and the heads of the other four metatarsals—one side of this tripod has to bear under these conditions continuous exaggerated strain, as the result of which it begins to give way. The arch therefore sinks and the arch fraction is increased and symptoms of foot strain appear.

To test the truth of this observation that the weight bearing strain in booted individuals falls mostly on the lateral side of the posterior pillar that is the heel and the medial side of the anterior pillar that is the ball of the great toe, I examined the shoes of certain of these doctors which have been in use for more than one year and been continuously worn (Fig. 10). It will be seen that the most marked wearing effect is present in the postero-lateral portion of the heel and the antero-medial portion of the shank. This proves that the axis of weight bearing in such cases passes diagonally across the long axis of the foot and the shoe and is an obvious mechanical disadvantage so far as the maintenance of the arch is considered.

Another disadvantage of the abducted foot is the associated crowding of the toes especially the abduction of the great toe. In a normal unrestricted foot, the toes being in line with the "five longitudinal arches" previously mentioned help the metatarsals by partaking in some of the strain. This is especially true in the case of the great toe. The mild degrees of hallux valgus present in the feet of booted individuals prevent the great toe from furnishing this desired assis-

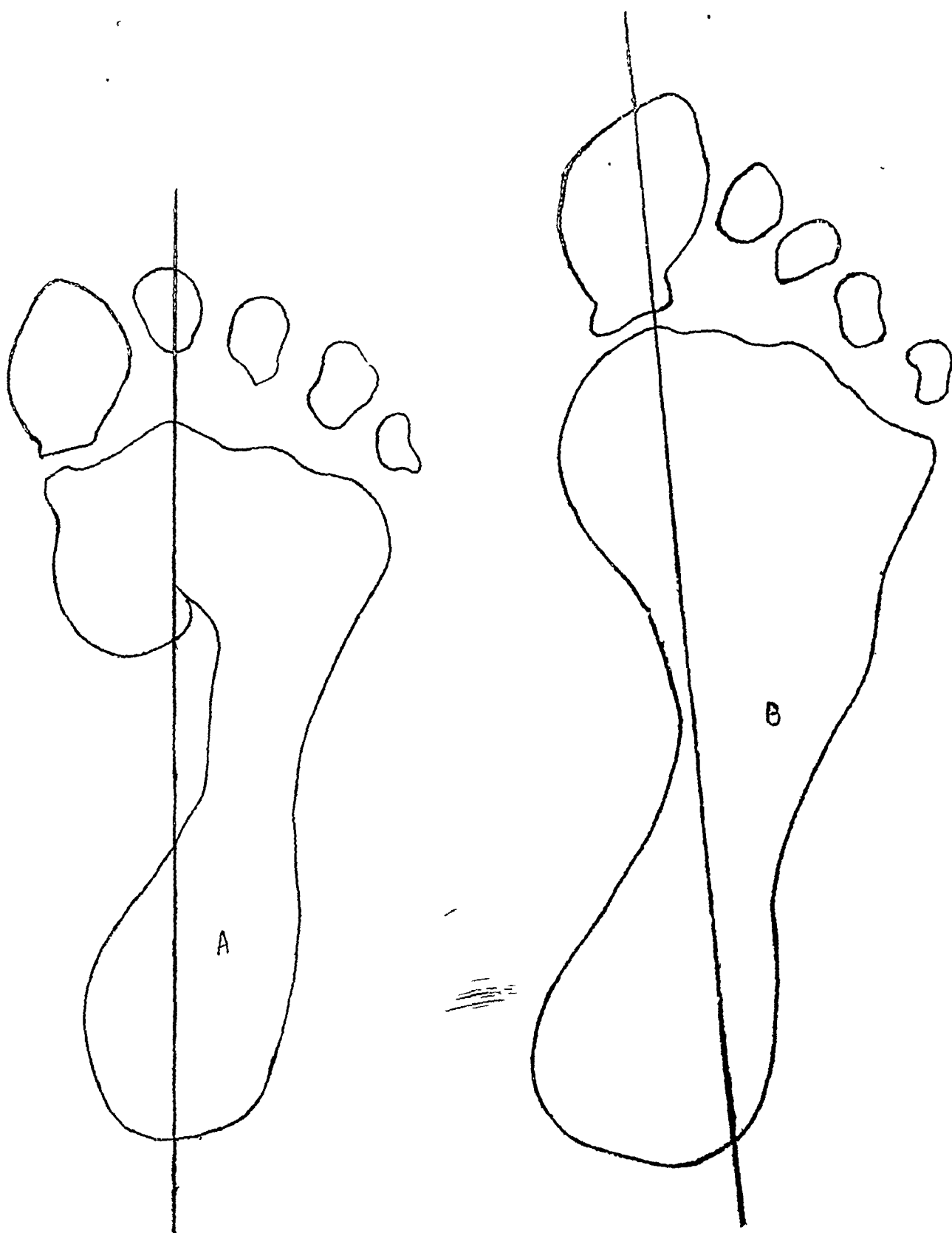


Fig. 9.

Axis of weight bearing in Abducted and Adducted foot.

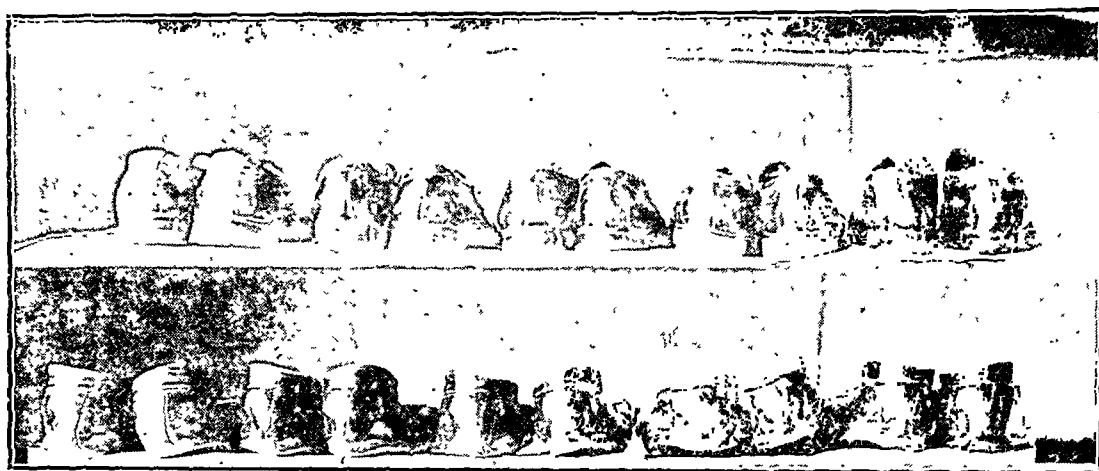


Fig. 10.

Shows the wearing effect on the postero-lateral portion of the heel.

tance to the head of the first metatarsal which therefore from this respect also is made to bear increased strain. It must be remembered that normally the great toe forms the buttress of the anterior part of the inner arch as it broadens the weight bearing area and thus stabilises the foot. If displaced outwards the great toe cannot grip the ground as it should and furnish a fixed point from which the muscles serve in maintaining the arch. The importance of the digits is also emphasised by Fairweather (1926) who says that nature intended the digits of the three inner toes to be carried

in one continuous curve with their metatarsals so as to continue the central part of the foot as an arch from the os calcis to the terminal phalanges of these three toes. "This would make the foot a very efficient shock absorber and is the condition met with in races who do not wear shoes." The abduction and crowding resulting from wearing modern shoes take away this helpful action of the digits and especially in the case of the great toe may be one of the determining factors in causing foot strain and depression of the arch.

*(To be concluded.)*

## CASES & COMMENTS

### A CASE OF SACRO-COCCYGEAL CHORDOMA\*

by MISS V. C. ANGULI.

The notochord is the most primitive axial skeleton in the vertebral column and is represented at an early stage in the ontogeny of all the higher vertebrates. The mesoblast around the primitive axis of the notochord develops into the spinal column. The notochord becomes enclosed in the bodies of the vertebrae and in the base of the cranium, and eventually degenerates. In adult man traces are found as the nucleus pulposus of the intervertebral disc. Occasionally, a portion of its cranial extremity persists at the base of the skull and a portion of its caudal extremity in the region of the coccyx. The remnant at the base of the skull is said to be present in about 1% of all autopsies.

Chordoma is a rare tumour arising from the remnants of the notochord. It occurs chiefly in two situations corresponding to the cranial and caudal ends of the notochord. It is a benignly malignant neoplasm with a tendency towards local recurrence and rarely giving rise to metastasis.

#### CASE REPORT

A teacher, 32 years old, was admitted into the surgical wards on 4-5-46 for vague discomfort and difficulty during defaecation of two years duration. He was a well built individual in good health. He gave no history of previous illness or injury. The vague discomfort started insidiously and was associated with constipation; bowels being evacuated once in 3-4 days. There was a little pain in the ano-rectal region but it was not a prominent feature. There was no tenesmus. The patient gave no history of passing blood or mucus per rectum. He had occasional attacks of retention of urine, relieved by catheterisation. He had a sciatic type of pain shooting down to both extremities in addition to the pain in the ano-coccygeal region.

Local examination revealed a swelling in the sacro-coccygeal region. The skin was freely movable over the swelling. There was a saddle shaped area of anaesthesia in the perineum. Knee and

ankle jerks were brisk and the plantar response was flexor.

Rectal examination revealed an elastic mass, arising from the anterior aspect of the sacrum and projecting into the rectum. The margins of the tumour could not be made out definitely. It was fixed to the sacrum while the rectal mucosa was intact and was movable over it. No definite fluctuation could be elicited.

#### INVESTIGATIONS

Urine: Sp. gr. 1020. Acidic. No albumin. No sugar. No Bence-Jone's proteose. Nil deposit.

Motion: Well formed. No blood or mucus. No ova or cysts.

Blood: Group 'B'. R.B.C. 5.12 millions. Hb. 105%.

W.B.C. 7200. Diff. count. P62, L32, M4, E4. B.P. 125/80.

Aspiration biopsy: The smear showed the characteristic very large vacuolated cells of chordoma with a few R.B.Cs.

On 28-6-46, under gas and oxygen anaesthesia, the following operation was carried out by Dr. C. P. V. Menon. The anus was closed with a purse string suture. An inverted T-shaped incision was made so that the vertical limb was over the median cleft and the horizontal limbs lay over



Fig. 1.

Sialogram showing the extensive destruction of the sacrum.

\*From the Surgical Wards of the Govt. General Hospital, Madras.



the gluteal folds on either side. The flaps were dissected up and the glutei were separated from either side of the sacrum. The growth was approached through the interval between the coccyx and the rectum. Anteriorly it was free from adhesions to the rectum. The tumour was removed after disarticulating the last piece of the sacrum. The cavity was plugged with roller gauze and the wound was closed in layers.

There was a rapid fall of B.P. during the operation and the pulse became imperceptible; with the usual measures his condition improved and the operation was completed. 400 c.c. of whole blood was given from the beginning of the operation and was followed by a glucose saline.

The patient died 16 hours after the operation due to secondary shock. There was no oozing from the wound.

#### MACRO-PATHOLOGY

The specimen was a pyriform tumour (5"/3") with a definite capsule which had been broken through over a small area posteriorly by the growth. The coccyx was partly embedded in the tumour. It was semifluctuant. The cut surface was composed of grey gelatinous tissue with intervening strands of fibrous tissue and scattered pools of haemorrhages.

#### MICRO-PATHOLOGY

The classical physaliphorous cells of Virchow were seen in alveolar pattern. The cells were large and polyhedral with pale staining cytoplasm

and well staining nucleus. The most characteristic feature was the presence of large vacuoles in the cytoplasm. Certain areas gave the appearance of syncytial cell masses with vacuoles.

#### DISCUSSION

Chordoma is one of the tumours where the histological features recapitulate in a striking manner the ontogenetic and phylogenetic evolution of the notochord. It is recorded in the literature that it is difficult to distinguish this from colloid carcinoma of the rectum and myxochondro-sarcoma of the sacrum. The very firm and extensive attachment to the sacrum and the integrity of the skin were the distinguishing points in favour of the diagnosis.



Fig. 3.

Photograph of the specimen.

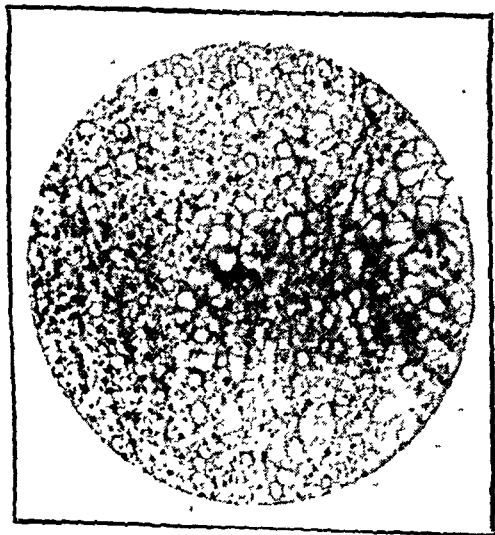


Fig. 2.

Microphotograph: the characteristic large vacuolated cells of chordoma are seen.

Thomas Howitz has studied a series of early human embryos and demonstrated the marked tortuosity of the notochord in the terminal segments due to regression of the tail in man, which was first evident in the 15.5 mm. embryo. The ectopia of the notochord results as a result of this regression,

which explains the occurrence of chordoma in the sacro-coccygeal region.

Ribbert in 1894, has proved experimentally in rabbits that escape of chordal material through insignificantly small defects made by simple puncturing of the intervertebral discs with a needle resulted in the development of tumours similar in morphology to chordoma.

The importance of trauma in the aetiology of sacro-coccygeal chordoma is mentioned by several writers, in particular by Bernard and Peyron—who suppose that severe sacrococcygeal trauma might be a factor in the liberation of cordal tissue from its normal osseous control and might even excite proliferation.

It may not be out of place to speculate that with the advent of the age of accidents

and increasing reports of herniation of the nucleus pulposus, we should expect more cases or tumours similar to chordoma arising from traumatically displaced chordal remnants present in the intervertebral discs.

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# THE INDIAN JOURNAL OF SURGERY

Vol. X

SEPTEMBER 1948

No. 3

## ACUTE ANTERIOR POLIOMYELITIS

by M. G. KINI.

Poliomyelitis is a subject which has attracted very little attention in India. The existence of this disease in olden times has become evident from a study of the deformities of the limbs in Peruvian skeletons and Egyptian mummies. Egyptian Stele of the 18th dynasty as well as Spanish and other paintings, several years old, show the existence of this disease. It has not been possible to get a correct description of this disease in Ayurveda. It is probable that the brother of Catherine the Great was attacked by this disease when a year and a half old and was left a cripple. He was born in 1734. Sir Walter Scott who was born in 1773 was afflicted by this disease when he was a year and a half old and was left with a paralysis of the right leg. Underwood (1789) in England and Heine (1848) in Germany described the disease when it occurred sporadically. Little who was born in 1810 and who became the Father of Orthopaedics in England, was smitten by this disease. One of his reasons for joining the medical profession was to study the cause of this disability. After qualifying he sought enlightenment in England about himself with a desire to improve his defect. He failed. Louis Stromeyer in Hanover solved his difficulties by tenotomising the tendo-achilles of his foot in 1836. Little in his turn did the same operation for the first time in England in February 1837. In 1841 Colmer described the epidemic form of the disease in America and later in 1881 a correct description of the epidemic form was given.

In recent times, the late President Roosevelt, a long sufferer from this disease, has

carried his nation through to victory in spite of his disabilities and at the same time he has laid the foundation for investigation and improvement of treatment of poliomyelitis.

The general practitioner with poor basic training in this subject feels a sense of defeatism when he has to treat cases afflicted with this disease which may not be a constant feature in his practice. He has no facilities also to keep abreast of advances in this aspect. In his anxiety to save a catastrophe he permits anything to be done as he has no proper guidance in this matter even though he is anxious to seek it.

Having worked in this line for sometime, a scheme for the treatment of this disease on a more scientific and practical basis is suggested.

Infantile paralysis though it does not take a toll of life, yet causes serious disabilities leading to deformities and is an important factor in the production of cripples. It is an infectious disease and it affects children usually; in severe epidemics adults are also affected. It comes on with such dramatic suddenness that it makes common people in India think that this paralysis is due to an evil eye or the devil and a lot of time is wasted in invoking and appeasing the evil spirits, by incantations and sacrifices, by the wearing of charms and by the use of drugs of doubtful value, and by adopting indigenous and purposeless massage which is mechanical and monotonous.

A lot of experimental work was and is being done and elaborate researches of 40

years have elucidated that this disease is due to a virus infection. This virus is ultra-microscopic. To give a crude idea of the minuteness of this virus, it may be stated that it may take 2 to 3 million viruses queued up to make a line 1 inch long. It took a long time to find the cause of this disease. Now that the cause is found, our attention is necessarily directed to the prevention of this disease. For this, it is necessary to study the mode of spread. At one time, the hypothetical view of olfactory spread was held but this has since been proved incorrect. Squirming children were subjected to irritating douches of various types in the nose, mouth and pharynx causing annoyance to them but the children got the infection all the same. More recent investigations have elucidated that the spread occurs through the nerve terminals of the nose, tonsils, pharynx and also of the gastro-intestinal tract. It has been found that children suffer most after tonsillectomies during an epidemic and that the mortality ranges high. This shows that the raw area left after a tonsillectomy gives a free venue of entrance to the virus. Therefore it is inadvisable to have tonsillectomy operations or any operations in the region of the nose in children or adults during an epidemic.

The virus has been grown from the nasal, oral and intestinal discharges. The discovery of the virus causing intestinal infection with the usual clinical manifestations was due to the elaborate work of Dr. P. H. Harmon of the University of Chicago. Dr. R. John Paul and the late Dr. James D. Trask of Yale found the virus in sewage also.

The role of flies as carriers was demonstrated by trapping flies in the area where this epidemic occurred and the virus was cultivated from these. We all know that flies are the cause of the spread of many diseases of the gastro-intestinal tract and poliomyelitis is also considered as one of the many infections affecting the gastro-intestinal tract spread by the flies. Decayed teeth may form a source of infection and it

has been proved experimentally that if the virus is plugged into the drill hole of the tooth of a monkey, the monkey develops poliomyelitis in quick time through the nerve endings of the roots of the teeth. Investigations carried out by Dr. Hans Reese, a neurologist and Dr. John G. Frisch, a dentist of Madison, Wisconsin, in children with decayed teeth have shown the presence of the virus of poliomyelitis in these teeth. The exciting causes favouring the onset of this disease are chills, fatigue, colds, accidents—factors which should not be ignored.

By whatever route it gets into the system, this virus has a particular affinity for the grey matter of the brain and the spinal cord. Hence the word "Poliomyelitis" derived from Greek. When this grey matter is attacked by this virus, it kills those delicate cells which send out processes concerned in the neurotisation of the skeletal muscles and if these cells get destroyed by this virus, the muscles supplied by these cells will degenerate and thus the function will be interfered with. It must be clearly understood that what looks like a massive infection is always not so. The toxins of the virus may kill a few nerve cells outright and also stupefy the neighbouring cells. This is the reason why we get a false impression of a massive paralysis. The moral of this is that we should not give up hopes when we see massive paralysis but concentrate our attention on the recovery of all the muscles paralysed. By skilful attention all the muscles stupefied may recover leaving a residual paralysis which will be negligible and easily corrected.

#### THE PATHOLOGY OF POLIOMYELITIS

The first observation on the pathological changes in poliomyelitis of the spinal cord was done by Charcot (1870) who found changes in the anterior cornual cells of the spinal cord. The development of pathological observations has been slow and halting and has been attained by laborious investigations. Post-mortem examinations of poliomyelitis cases were few and far be-

tween with the result that no contributions occurred which had any bearing on the clinical symptomatology. However, the discovery of the virus of poliomyelitis has enabled investigations to be carried out experimentally in monkeys and chimpanzees. The findings have enabled us to interpret the pathological changes in human beings and to co-ordinate them with the clinical findings. More post-mortems in epidemic times have clarified some of the changes occurring in poliomyelitis. In 1908 Cadawaladar reported changes in the anterior cornual cells, ganglion cells and interstitial tissue and in 1910 Lewis reported perivascular infiltration in the vessels of the grey matter with involvement of the lateral and posterior horns in monkeys.

In 1910 Krause described inflammatory changes in the medulla, pons and basal ganglia (in addition to the changes in the ganglion cells). Blanton (1917), a few years later, confirmed in his autopsies the findings of Krause and found additional changes in the cortex and the cerebellum. Kornye (1933) described mesodermal and glial changes in the medulla in addition to the changes in the anterior cornual cells.

Peters (1938) after investigation of 17 autopsies described changes not only in the anterior horn cells, but also in the posterior and lateral horns and also in the intermediate cells and he called this the internuncial pool. The internuncial pool described by Peters is the significant observation and probably explains some of the peculiar residual occurrences of paralysis. These pools have been found in the cervical and lumbar enlargements in the lateral portion of the anterior horn in addition to the constant and segmental clusters which occupy the more medial portions. Sano and Bruce have stated "as more muscle groups appear additional clusters are added in such a fashion that the more distal muscle groups have nuclear representatives in the increasingly lateral portions of the anterior horns. It seems possible that the destruction of the cell cluster in a given cross section may mean little or nothing to the function of the

muscle which is supplied by muscular nuclear column." The medullary nuclei of some of the muscles spread over a number of spinal segments while others, for instance, the *Tibialis Anterior*, spread over a few only. This may explain why some muscles are more likely to escape complete paralysis than others. It has been proved that the pathological changes observed in the anterior horn cells are not of a permanent nature and are reversible as in the glial tissue and this probably explains the recovery of the muscles after apparent paralysis.

The physiological conception of plurisegmental control of individual muscles has been established and where this plurisegmental control is limited, the destruction of the muscle becomes complete as in the case of the *Tibialis Anterior* which remains as the only residual paralysis after an initial massive paralysis. In some cases, the symptoms of hyperaesthesia were so remarkable that it was one of the main features of the clinical observations of the parents, viz., that the children shrieked with the slightest touch. Paralysis of two or more limbs subsequently developed. These cases were also associated with spasm. Later the recovery became more and more complete leaving a small residual paralysis of the *Tibialis Anterior* muscle. Definite changes in root ganglia have been shown.

Various aspects of physiological reactions in sections from ganglia removed at post-mortems and their response to faradic and galvanic currents have been studied but in my experience these have not been quite useful. The contractions felt by the fingers have been more useful than the electrical reactions.

Chronaxia as a guide to the physiological condition of the muscle was studied during World War No. I and this may serve as a guide in the interpretation of paralysis and its recovery. Chronaxia, derived from the Greek words *chronos*, meaning time and *axia* meaning measure, was based on the fact that the strength of the stimulus ap-

plied to initiate response takes some time to produce excitability. The stimulus must last for sometime and so is defined as a galvanic threshold when an intensity of twice the Rheobase is used. Chronaxia of individual normal muscles have been worked out and found to vary between .06 and .50 milli-seconds, e.g. the average chronaxia for the Deltoid is .10 milli-seconds and for the Extensor Digitorum Communis is .30 milli-seconds; in paralysed conditions this may be 12.0 milli-seconds for the Deltoid and 18.0 milli-seconds for the Extensor Digitorum Communis.

In paralytic muscles excessive excitability may lead to fatigue and so the use of the electric current in the excitation and treatment of the paralytic muscles must be done with great care. Proebsesters (1928) made an important observation that there was no parallelism between the excitability and the tension strength of the paretic muscles.

The existence of spasm is not an indication of degeneration. The loss of inhibitory action between the internuncial group and the higher centres probably explains the spasm. The findings of Kabat and Knap (1943) are definite about the lesions in the intermediate cell group. The use of prostigmin was suggested by them to overcome the loss of the inhibitory action of the internuncial group of cells as they believed this drug relieved the hypertonus and hyperirritability and reduced in-coordination. The spasm in the muscles which Sister Kenny observed has been studied from the physiological aspect. It is believed that the spasm represents dysfunction of the intermediate cell group due to interference with impulses coming down from the higher centres which are relayed through these cells. The observations of Miss Kenny about mental alienation are probably due to lesions found in the basal ganglia and have been borne out by experimental investigations conducted by Bodain (1941).

A comprehensive experimental investigation was undertaken by Bodain and Howe (1941). Their observations on virus infection through the peripheral nerves, through

the gastro-intestinal tract, and through the nasal route are illuminating. The portal of entry through the olfactory route in man has definitely been disproved while rhesus monkeys and chimpanzees could be injected through the olfactory route. Pathological study confirmed the findings of the previous observers regarding the cranial changes.

Sister Kenny's concept of spasm, mental alienation and in-coordination have been investigated by Moldaver (1944). He stated that the so-called alienated muscles had definitely degenerated as tested by chronaxia. He also found that where there was spasm chronaxia was normal. He also stated that in-coordination occurs whenever there is paralysis due to impairment of voluntary and autonomic control and this is borne out by clinical experience.

Bodain and Howe showed the difficulties in conducting immunological experiments in animals but the conclusions arrived at are interesting. They state that it is not illogical to conclude that subparalytic immunity exists in man whereas such subparalytic virus activity cannot be demonstrated experimentally in the rhesus monkey. One may hazard that immunity in man is acquired without previous frank infection and may come either through participation of humoral factors in neutralising the virus before it is fixed in nerve cells or not inconceivably, by alterations through the humoral and metabolic factors in mucous membranes or other barriers against the entrance of the virus into the nervous system.

It is therefore suggested that immunity in poliomyelitis in man is not the result of the immunisation of the nervous system but rather of some process which prevents infective quantities of active virus from reaching nervous tissue. Neuro-tropic viruses of the type of poliomyelitis can produce varying degrees of protection in the host organisms by operating on the central nervous system or on the tissues at the portal of entry.

Billig and Harreveld (1945) in their more recent observations on nerve lesions have

found that when nerves and nerve muscular end plates are crushed the regeneration exceeds the supply of axis cylinders over and above those present before crushing. This principle was applied in partially paralysed muscles by either open crushing of the motor nerves or by subcutaneously crushing the neuro-muscular nodes by a rivet gun. This method of crushing by a hand crusher was put into operation with beneficial results in some chronic cases which had a muscular power between  $1/5$  and  $2/5$  of the normal power. These showed signs of improvement and in one case of three years' duration, definite increase of power to  $4/5$  occurred enabling the patient to get about freely without the aid of splints. There is something in this line of treatment which deserves consideration.

Environment plays an important part in preventive medicine and this aspect has to be seriously considered in the disease. It is interesting to observe that in America and Canada this disease occurs in the summer months and in epidemic form in rural areas. A more clear assessment of the environmental aspects of this disease is being investigated and tons of money are being spent in this direction. The reason for this investigation is that more common ailments like colds, occur in the winter months but the epidemics of poliomyelitis occur in the summer months. It has also been found that the disease occurs in epidemic forms in the countryside and not in the cities. In the statement of cases appended, more cases from the cities are recorded. This requires investigation. The symptoms such as fever are more severe in Indian children than those occurring in America. This also requires investigation.

How is the disease to be recognised? Unfortunately, the symptoms of this disease resemble the common ailments, a "cold in the nose," slight fever, nausea, vomiting and headache. It may manifest itself as a slight stiffness of the neck and back or may follow gastro-intestinal symptoms, or mild lung signs and is sometimes associated with

severe neuralgic pains in the extremities. The only way to decide whether it is due to poliomyelitis is by routine examination on mere suspicion. Any case with stiffness of the neck and back deserves an examination of the spinal fluid for diagnosis. This can only be possible if the public health organisation and public opinion are also centred round this disease. In order to carry out these tests it is essential to have a good public health laboratory with an expert in virus culture for examination of the disease from all children as a routine. Efforts have to be redoubled if there is a case of meningitis or a case of frank paralysis. It is pleasing to state that the first attempts at isolation of the virus by injecting monkeys have been successful from cases in Madras (C. G. Pandit).

In this connection it would not be out of place to give a review of the epidemic in the Carnicobar Islands. The Government of India having been apprised of an epidemic in Carnicobar Islands flew planes with pathologists and doctors for the relief of the afflicted and their findings have given valuable information.

Subsequently, the author with a party of doctors, nurses, masseurs, and a virus culture specialist, was sent to the islands for treatment of those afflicted by this disease. Assessment of muscle paralysis due to the disease has been made and recorded in a special chart prepared on the lines suggested by Lucille Deniels et al (see appendix, specimen case sheet). This evaluation is based on a study of 127 cases.

	Major Paralysis	Minor Paralysis	Total
Involvement of 4 limbs	42%	20%	62%
Involvement of 3 limbs	2.5%	2.5%	5%
Involvement of 2 limbs	13.5%	13.5%	27%
Involvement of 1 limb	1.5%	2.5%	4%
No limb involved—neck and thorax and cranial nerves alone affected	0.0%	2.0%	2%
Total	59.5%	40.5%	100%

Several conclusions are tentatively drawn from this epidemic :—

(1) When the epidemic attacks a virgin soil, the infection is heavy and the mortality is great. There were 209 deaths in a total of 873 cases (Col. Kapila). The statement below gives the state of affairs at the time the party reached the camp for assessment and treatment of paralysis.

(a) Total number of admissions at the camp hospital (according to register maintained since the camp hospital was started) ..	551	
Total number of deaths ..	100	
	---	451
(b) Total number of inpatients assessed (these were the patients still remaining in the hospital at the time of taking charge) ..	143	
Deaths ..	2	
	---	145
(c) Total number of outpatients completely recovered — re-examined from villages ..	201	
(d) Total number of patients assessed for paralysis (cases that were discharged partially cured before taking charge) ..	71	
(e) Cases that could not be traced ..	34	
	---	306
		---
		451
		---

The following types of bulbar paralysis were recognised in this epidemic.

(a) Upper cranial group involving the 5th, 6th, 7th and 8th cranial nerves. These were not serious and the patients recovered and in a few cases were left with residual paralysis of the facial or eye muscles.

(b) Lower cranial group of nerves involving the 9th, 10th and 11th cranial nerves afforded a serious problem and were responsible for the great mortality as they interfered with deglutition and respiration.

(c) The bulbar central autonomic group, composed of the bulbar central group and the bulbar circulatory central group were also responsible for the deaths. There were some cases of bulbar cervical thoracic cord group. These remained alive but had complications of lung, etc. and two died after the author took charge.

(2) Multiple cases of poliomyelitis occurred in a family and the age group was between 1 and 6, 6 and 10. Age group between 6 and 10 was commonly affected. There were some cases between 16 and 20 and 21 and 25.

(3) Poliomyelitis was found to be contagious and infectious. 10 per cent of the individuals in the islands were affected.

(4) Though there were a lot of flies in the island, no investigations were carried out regarding the role played by them in the causation of this disease due to difficulties in virus culture.

(5) 475 out of 873 people were abortive cases (Col. Kapila) and probably there were many other unrecognised infections without producing any symptoms to attract attention for reporting sick even during the course of this epidemic.

(6) Experimental work could not be carried out on a large scale and to a minimal extent spinal fluid examination was done. But in spite of this, due to the genius and foresight of the Director-General of Health Services, Dr. Jivraj N. Mehta, planes were flown with equipment and personnel to meet the situation. Some rhesus monkeys were flown for virus culture and investigations will be published which will open up new channels for investigation of this problem. The monkeys taken have got infected and exhibited signs of paralysis. (C. G. Pandit).

(7) There were two groups of clinical manifestations very well described by Col. Kapila. The first group had headache, nuchal pain, rigidity, drowsiness and congested eyes. These were cases which developed into various types of bulbar paralysis and paralysis of the upper limbs. The other group



had fever, headache, nuchal pain and pain in the small of the back and in the lower limbs. These patients did not look ill. If they developed paralysis it was of the lower limbs. Some of the first group of cases were extremely acute and death occurred due to respiratory failure within 12 hours of onset.

(8) Earlier observations by Casey, Aycock, Kessel and Gordon on the infection and incubation periods were well appreciated in the epidemic in the islands and the high percentage of patients in a rural epidemic have been substantiated in this epidemic as the conditions in Carnicobar Islands are of a rural type.

(9) Present methods and criteria for the diagnosis of the disease must be revised.

In a good public health organisation, anticipation of an epidemic may avert it and this is the ideal to be aimed at. America is anticipating a big epidemic and all public health laboratories are working overtime for examination of all possible sources of infection including children to see if they harbour these germs. It is a mighty effort but is essential to the prevention of the disease. It is interesting to observe that in an epidemic where this type of investigation was carried out, a large number of people were found to have positive cultures even though they had no symptoms of paralysis, an infallible sign of poliomyelitis. This goes to prove in the majority of cases they had in the early stages developed an active immunity by this infection without suffering from paralysis. Some of them act as carriers as they retain the germs and are potentially dangerous. These are the cases difficult of recognition. By wholesale investigation of the discharges and by isolation we will be able to prevent epidemics.

The disease occurs in sporadic and epidemic forms. In future to prevent the occurrence of this disease it is necessary to concentrate our attention and study the disease in four phases—(1) the pre-paralytic phase, (2) the paralytic phase, (3) the post-paralytic phase and (4) the inter-epidemic phase.

It is unfortunate that we have no authoritative figures in our country. An attempt is however being made to collect figures but the figures obtainable in general hospitals are very unsatisfactory as special concerted effort has not been directed towards this purpose. It has been found that the cases that come to the hospital are more from the cities than from the countryside. It is possible that there are more cases occurring in the countryside and due to ignorance and difficulties they are not able to seek the advice available in general hospitals. The statement appended to this paper gives an index of the incidence of this disease occurring in the districts and is based on this year's (1947) concerted effort to gather statistical records. The sporadic existence of this disease should be taken as a warning by public health organisations in India. At any time when conditions are favourable, an epidemic might occur which will be a serious problem as there are no organised clinics for this purpose in this country.

A lot of cripples due to this disease can be found scattered and are usually seen round bazaars, market places, places of pilgrimage and are the human wreckage as an aftermath of this disease. They try to make a living by exhibiting these deformities.

It is my intention to bring it to the notice of the medical practitioners, the public health authorities and the surgeons and physicians interested that a scheme of collecting information is essential to gauge the scourge due to this infection and that legislation should be enforced to make this disease a notifiable disease. Institutions must be started for treatment of this condition. Though the mortality from this disease is not high, yet the manifestations of this disease, usually lead ultimately to human wreckage.

Naturally the question arises "What is it that we have to do and what is the treatment?" The preventive aspect of the treatment is the most important thing and we know that concerted attempts are being

made in the countries where this disease occurs in an epidemic form and where public opinion is ranged high. In the course of an epidemic, all the children and contacts are examined for this type of virus by bacteriological methods by the public health laboratories. Isolation is attempted by education and sometimes by compulsion where the people are not amenable to reason. The method of preventing this disease is by developing what is called "active immunity." Some children get it as stated before by natural methods by suffering from a mild infection early in life. The least dangerous way to develop active immunity is by a vaccine injected into the child. Two vaccines were developed one of which was produced from the dead virus and the other from the attenuated virus. Experiments from the dead virus were futile and those from the attenuated virus proved dangerous and it was not used on human beings. This shows the progressive but halting nature of modern medicine. Nothing should be put on the market before trial. There are two more new vaccines on the horizon which are full of hope and promise. It is hoped that the scourge of poliomyelitis may be controlled by vaccination during the epidemic time or the children may have to be protected by routine vaccination as in the case of small-pox and diphtheria when a successful vaccine has been discovered.

Passive immunity is another aspect of treatment and is got by injecting the serum from convalescent patients. Injection of gamma globulin has been tried by Bhalke and James Perkin. The conclusion "serum in any form for all practical purposes is ineffective in the therapy of poliomyelitis" has been arrived at by them.

Specific drugs have not been found but attempts have been made which have not so far been successful. It is likely that with further experimentation and with the recent advancement in the knowledge of antibiotics, a new drug may be found for the cure of this virus infection but this can only happen by efflux of time.

Symptomatic use of drugs which control spasms of muscles is being done. The work of Dr. Nicholas Ranshoff of Longbranch, New Jersey, is an attempt in this direction. He used curare. This drug paralyses the skeletal muscles including the muscles of respiration and has to be employed carefully. It is under careful trial. It is now being used in surgery for getting complete relaxation in anaesthesia and is also being used for this condition to overcome the spasm in muscles in the acute stage of the disease. It was not possible to evaluate the scope of this drug as very few cases came early. Moreover this drug was made available in India only very recently and though opportunity existed to try this in the Carnicobar Islands it was not done due to lack of facilities in the island for counteracting the consequences.

Prostigmin is another drug and the trial of this drug has been done on a large scale in the Carnicobar Islands epidemic in treating the spastic conditions. While it has given some good in three cases out of 127, in the majority of them it proved ineffective.

The course of the infection may be divided roughly into three stages—the acute stage, the convalescent stage and the chronic stage with complete or partial wreckage of the skeletal muscular system with arrest of the growth of some bones of the skeleton in some cases producing from very mild to serious deformities associated with mild or serious contractures. In the acute stage, it is the general practitioner who has a chance of seeing and treating common ailments in children. A wise practitioner will always exclude the possibilities of two important dreadful diseases, one that takes a heavy toll of life, viz. diphtheria, and the second that maims a child for life. Immediately, poliomyelitis is suspected, a proper qualified doctor to treat this must be consulted. There is no better person for this work than a well trained orthopaedic surgeon.

During the acute stage, apart from the treatment of symptoms, attention must be concentrated to conserve the paralysed

muscles. Sister Kenny's treatment which has been used in recent times has been based on the principle that the muscles paralysed are in constant spasm with mental alienation interfering with function. She has devised the system of hot packs, hydro massage with early exercise of the paralysed muscles from the very start discarding the use of splints. Treatment by hot packs was put into practical effect in the Carnicobar epidemic with beneficial result in the cases where there was spasm.

This new treatment was in the headlines of the lay press and in some medical journals. People thought that a millenium had come for the relief of these poor unfortunate children. America, quite quick to try anything new decided to try the efficacy of this new venture. With this object, Sister Kenny was imported to America in 1940 and given all opportunities in various universities to demonstrate her treatment and the result of this investigation has been a balanced report which states that while not denying that some good can result from her treatment, the exaggerated claims put forward for her treatment are not quite justified. It is also very expensive. It therefore becomes plain that people in their anxiety to cure a hopeless case usually try to do anything that is new like the drowning man catching a straw to save himself. It is only when these new treatments and new drugs are put to the acid test by using them on a large scale, by watching the results with follow up records, will we be able to evaluate the treatment adopted. Therefore it is wrong for the lay press to advertise such treatments without sufficient trial in scientific institutions. In my opinion in the early stages, splinting, massage and hot packs have a place in the treatment. This must be done judiciously. Thus splinting, massage, exercises and probably the use of drugs like curare and prostigmin under control have a useful place in this treatment. For this a good organisation is necessary. This should consist of a hospital organisation with a good orthopaedic surgeon with a team of masseurs and

physiotherapists and a rehabilitation centre with facilities for occupational therapy. A lot of patience is required on the part of the patient, the nurse and the doctor. To get the desired result co-operative and co-ordinated effort would be necessary and for this an organisation with a suitable clinic in every teaching hospital should be provided and later in every district hospital. How can one treat the disease efficiently if the orthopaedic surgeon is to be the surgeon, the masseur, the physiotherapist and what not as it is at present.

In the convalescent stage, the treatment should be the evaluation of the muscular recovery for which a definite chart has to be drawn and each muscle tested and numerical values given, rested, worked, rehabilitated and later splinted for locomotion after having given sufficient time for the recovery of the muscle to permit of ambulation. Ambulation should not be permitted when there is a prospect of improvement in the strength of the muscles. If in the course of the treatment, the muscular power increases to  $\frac{3}{5}$  it must be the aim to increase it to  $\frac{4}{5}$  instead of permitting the patient to hobble about by splinting him for purposes of ambulation. I am quite convinced that a careful study of the muscle strength must be made and assessed to permit ambulation. Herein lies the secret leading to perfect recovery in some cases and reasonable in others. Ambulation can be permitted with splints when the prospects of recovery are poor after sufficient trial.

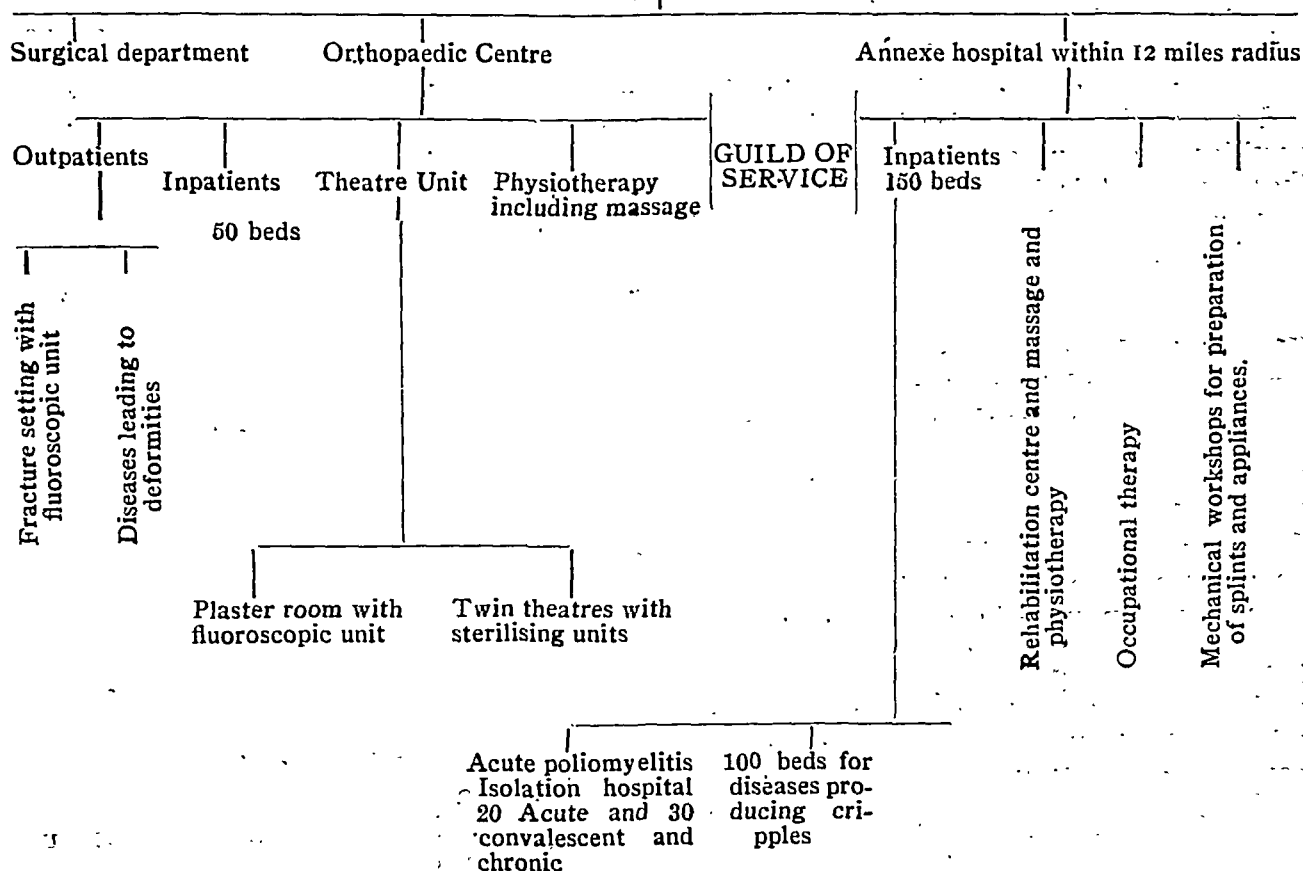
In recent times Dr. Harvey Billig and Dr. Antonio Van Harreveld of California have introduced a system of operation called Neurotripsy. It is an attempt to speed up neurotisation of the muscles by pounding the nodal points of the muscles with a special electric gun. I have tried this method and have had some dramatic results in chronic cases and probably this would be very useful during the convalescent stage, when progress becomes slow and stationery after regaining  $\frac{2}{5}$  of the power.

In this connection, an incident deserves mention. One lady from Bombay who is well placed and is a social service worker, had the misfortune of having a daughter smitten by this disease. She struggled to get the very best for her child in India short of going abroad and when at last she got some benefit from the treatment in Madras which enabled the child to get about without splints, she asked how she could repay her gratitude. She was advised to start a clinic for the cure of these unfortunate sufferers from infantile paralysis.

She took this to heart and has started a clinic in Bombay. This requires full public and Government support.

In the chronic stage when, well established deformities occur it presents the most difficult problem for the orthopaedic surgeon to solve. Even in these cases, many can be made into useful citizens. Modern advancements in surgery and aseptic technique have helped us to tackle this problem efficiently.

## GENERAL HOSPITAL



NOTE—This scheme is envisaged for the development of orthopaedic relief to the public with particular attention to poliomyelitis and using the facilities for occupational therapy and help in the supply of splints, artificial limbs, etc. If the Guild of Service should work in the rehabilitation centre and occupational therapy centre and help to secure such splints and appliances as cannot be got through the hospitals, it would be a great help in the after care of such cases and would be a unique and welcome feature.

Operations on tendons and muscles such as tendon lengthening, tendon transplantations, re-aligning the whole muscle to undertake a different line of pull, are useful adjuncts in the cure of cripples due to infantile paralysis. For more serious deformities, operations on the fascia and bones are done. Shortening of bones, lengthening of bones, and fusion of joints, are the methods that surgery can employ for the cure of cripples. Destroying the growing point of bones of the healthy limb to keep the symmetry of the body in cases where the affected limb ceases to grow is an operation designed to meet this deformity.

The whole outlook of the treatment in the chronic stage of human wreckage is well explained by the late Sir Robert Jones, a great savant in orthopaedics:—

"It must be the aim of every orthopaedic surgeon to make a man walk if he cannot walk at all, if he can walk to make him walk better if he can walk better to restore him to normal conditions."

To gain this end, it is necessary to have an organisation as the treatment of this paralytic disease is prolonged and has to be persevered in by the patient and the doctor and it must be the duty of every nation to have its own special clinics to restore persons to their normal conditions and save them from life long deformity and misery. Institutions should be developed for the treatment of those people who are in very poor circumstances. This is the pleading before the Association of Surgeons and the public of India. The scheme shown on page 222 is recommended for adoption.

Ambroise Pare, the Doyen of modern surgical inspiration including orthopaedics has pithily stated—

"Beautiful and best of all things is to work for the relief and cure of suffering, for little do ye know your own blessedness, for to travel hopefully is a better thing than to arrive and true success is labour."

### STATISTICS OF CASES OF ANTERIOR POLIOMYELITIS

District	Total	Males	Females	Upper limbs	Lower limbs including trunk
Madras	60	35	25	3	57
Guntur	16	8	8	2	14
Kistna	9	7	2	—	9
Chingleput	8	5	3	—	8
Tanjore	5	4	1	—	5
N. Arcot	3	2	1	—	3
West Godavari	3	1	2	—	3
Kurnool	2	2	—	—	2
Nellore	6	4	2	—	6
Coimbatore	3	2	1	—	3
Mangalore	3	3	—	1	2
					(one acute case)
Bellary	2	1	1	—	2
Nilgiris	2	1	1	—	2
Cudappah	2	2	—	—	2
Anantapur	1	1	—	—	1
Trichinopoly	1	1	—	—	1
Ramnad	1	1	—	—	1
Salem	1	1	—	—	1
Malabar	1	1	—	—	1
East Godavari	1	1	—	—	1

### OTHER PROVINCES

Cochin	1
Nizam	2
Punjab	2
Bombay	2
Mysore	1
Travancore	1

Total 137 cases plus 2 address unknown=139 cases

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# MUSCLE EXAMINATION

Key for evaluation of functions of muscles

5	N	Normal	Complete range of motion against gravity with full resistance.
4	G	Good	Complete range of motion against gravity with some resistance.
3	F	Fair	Complete range of motion against gravity.
2	P	Poor	Complete range of motion with gravity eliminated.
1	T	Trace	Evidence of slight contractility. No joint motion.
0	O	Zero	No evidence of contractility.
S	or	SS	Spasm or severe spasm.
C	or	CC	Contracture or severe contracture.

LEFT

RIGHT

				Examiner's Initials					
				Date					
NECK				Flexors					NECK
				Extensors					
TRUNK				Flexor					TRUNK
				Extensors—thoracic					
				Extensors—lumbar					
				R. ext. obl. } Rotators { L. ext. obl.					
				L. int. obl. } R. int. obl.					
HIP				Elevation of pelvis					HIP
				Flexors					
				Extensors					
				Abductor					
				Adductors					
				External Rotators					
				Internal Rotators					
				Sartorius					
				Tensor fasciae latae					
KNEE				Flexor—outer hamstring					KNEE
				Flexors—inner hamstrings					
				Extensors					
ANKLE				Plantar-flexors—Gastroc. & Soleus					ANKLE
				Plantar-flexor—Soleus					
FOOT				Invertor—Anterior tibial					FOOT
				Invertor—Posterior tibial					
				Evertor—Peroneus brevis					
				Evertor—Peroneus longus					
TOES (4 lateral)				Flexors—metatarsophalangeal					TOES (4 lateral)
				Extensors—metatarsophalangeal					
				Flexor—proximal interphalangeal					
				Flexor—distal interphalangeal					
				Abductors					
HALLUX				Adductors					HALLUX
				Flexor—metatarsophalangeal					
				Flexor—interphalangeal					
				Extensor—interphalangeal					

Additional Data :

Face.....  
Speech.....  
Swallowing.....  
Diaphragm.....

LEFT

RIGHT

	Examiner's Initials							
SCAPULA	Date							
	Abductor—Serratus anterior							
	Adductor—middle trapezius							
	Adductors—Rhomboids							
SHOULDER	Elevators							
	Depressor							
	Flexors							
	Extensors							
	Abductors							
	Horizontal Abductor							
	Horizontal Adductor							
ELBOW	External rotators							
	Internal rotators							
	Flexors							
	Extensors							
FOREARM	Supinators							
	Pronators							
WRIST	Flexor—radial deviation							
	Flexor—ulnar deviation							
	Extensors—radial deviation							
	Extensor—ulnar deviation							
FINGERS	Flexors—metacarpophalangeal							
	Extensors—metacarpophalangeal							
	Flexor—proximal interphalangeal							
	Flexor—distal interphalangeal							
	Abductors							
	Adductors							
	Opponens—5th finger							
	Opponens							
THUMB	Flexor—metacarpophalangeal							
	Extensor—metacarpophalangeal							
	Flexor—interphalangeal							
	Extensor—interphalangeal							
	Abductors							
	Adductor							
CHEST	MEASUREMENTS							
	Inspiration							
	Expiration							
ABDOMEN	Umbilicus to Ant. Sup. Spine							
LOWER EXTREMITY	Circumference—mid calf							
	Circumference—mid thigh							
	Ant. Sup. spine to int. malleolus							
	Umbilicus to internal malleolus							

Cannot walk  
Stands  
Walks with braces  
Walks with corset  
Other Apparatus.....

Date.....  
Date.....  
Date.....  
Date.....

Walks with crutches Date .....  
Walks with canes Date .....  
Walks unaided Date .....  
Climbs stairs Date.....



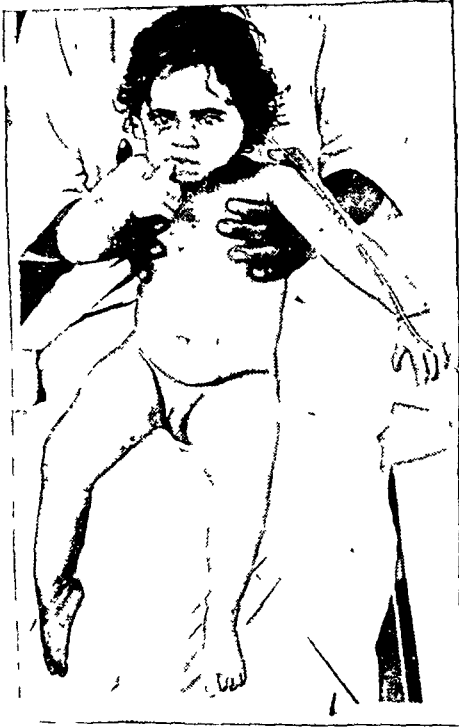


Fig. 1.

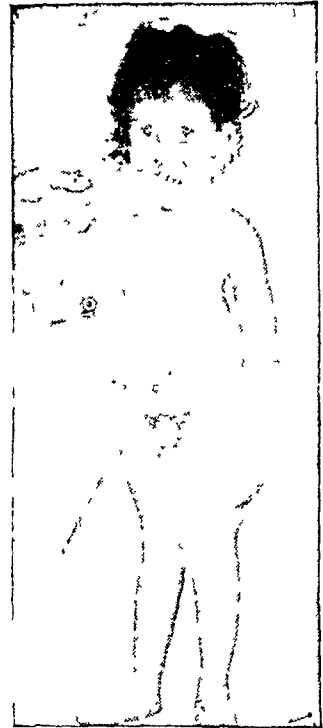


Fig. 2.

Fig. 1. Illustration showing the paralysis affecting the foot. Note the deformity.

Fig. 2. Illustrates paralysis affecting only the knee muscles.

These two are examples of children who suffer from Poliomyelitis with deformities of a minor nature which may be prevented by modern methods of treatment.



Fig. 3.



Fig. 4.



Fig. 5.



Fig. 6.

Figs. 3. to 6. Are illustrations of paralysis in the lower limbs showing the deformities that occur as a result of the disease.

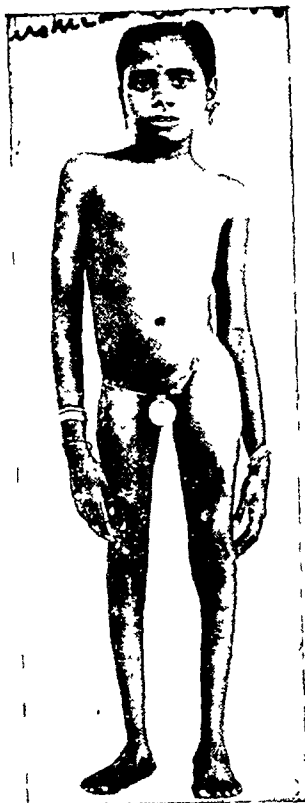


Fig. 7.



Fig. 8.

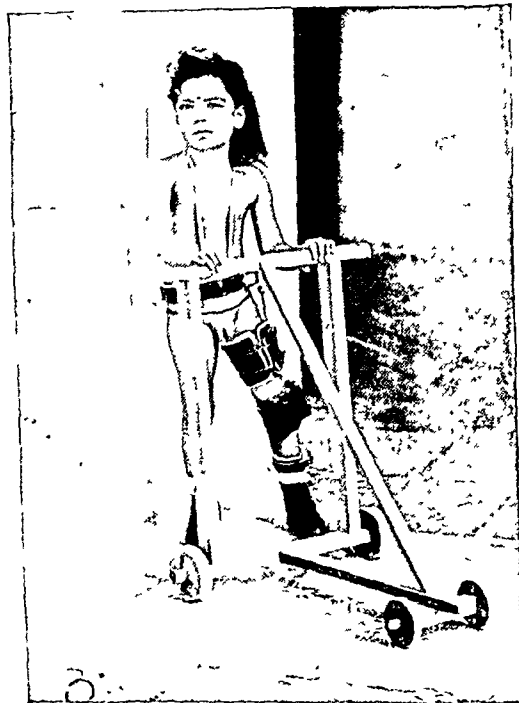


Fig. 9

Fig. 7. Is an illustration of a girl who was paralysed in both the lower limbs and had to crawl on fours. She had five operations, two on the feet, one in the region of the knees. After operations, the child was able to stand up.

Figs. 8. & 9. Show a child who is able to walk with the help of a caliper.



Fig. 10.

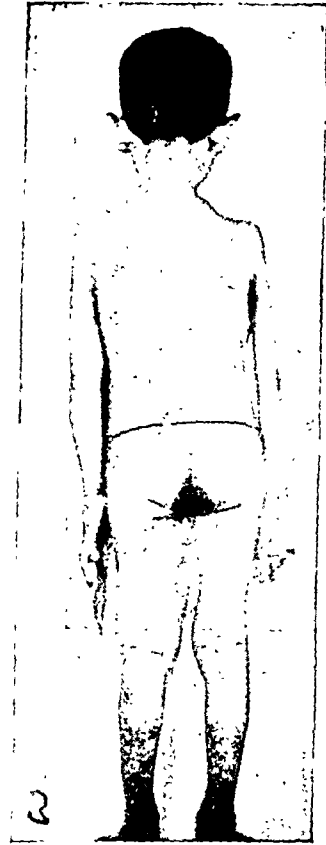


Fig. 12



Fig. 11.

Figs. 10. to 12. Are illustrations of shoulder girdle paralysis and the treatment adopted on a splint - constructed with plaster of paris.

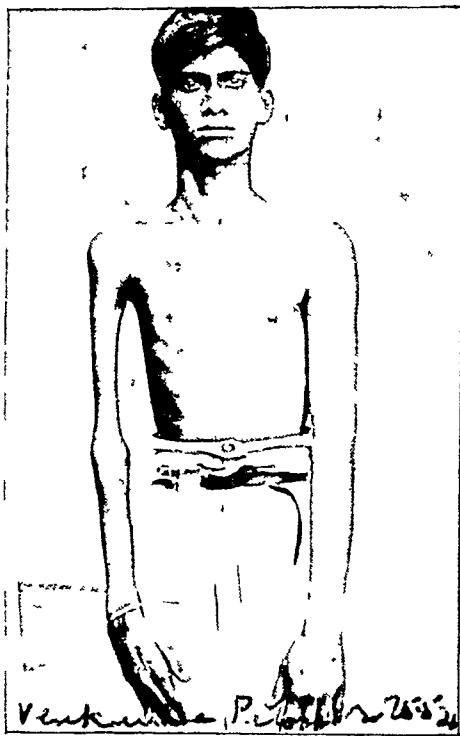


Fig. 13.

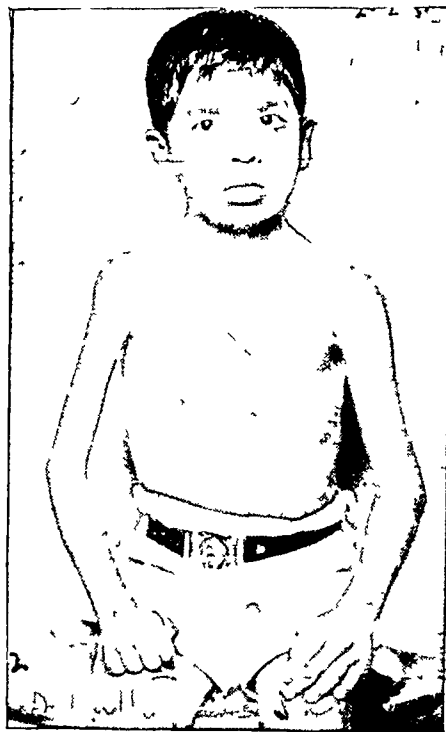


Fig. 14.

Fig. 13. & 14. Are examples of the paralysis of the shoulder girdle and upper limb. The paralysis of upper limbs is more serious than the lower limbs as the muscles do not recover as well as in the lower limbs.



Fig. 15

Fig. 15. Is an illustration of an adult whose shoulder girdle was paralysed but he can compensate for the paralysis by trick movements and is an example of the method adopted in re-education of muscles for getting some function of the limb. Had this man been under proper treatment the restoration of function might have been through a greater range.

# SOME OBSERVATIONS ON THE PHYSIOLOGY AND PATHOLOGY OF THE GALL-BLADDER

by V. M. KAIKINI.

One usually finds that in pathological conditions of the gall bladder, infection is always given primary importance; and anatomical abnormalities or physiological disturbances without which infection by itself cannot play its part, are rarely taken into consideration. For example, it is common knowledge that many people harbour *B. Typhosus* in their gall bladders and go about as typhoid carriers without themselves suffering from any symptoms of cholecystitis. This is due to the fact that these people have an anatomically and physiologically normal gall bladder which cannot be damaged by *B. Typhosus*. By experience it is found that a congenital anatomical abnormality and disturbance in the physiological working of the biliary system are the primary factors in lowering the resisting powers of the gall bladder so that it could be easily damaged by infective organisms.

## ANATOMICAL ABNORMALITIES OF GALL BLADDER

(1) *Intrahepatic Gall Bladder*.—Normally the gall bladder lies free over the surface of the liver fixed to it by a fold of peritoneum. In this abnormality some portion of the fundus is found buried in the substance of the liver. Two cases were noticed by me of this type.

Case 1. (Fig. 1.) A female patient admitted for persistent and severe pain in the right hypochondriac region for the last four years. History of severe attack of typhoid about nine years previously. The gall bladder was found to be atrophied with the wall very much thickened and fibrosed and the fundus firmly fixed to the wall of duodenum by a thick fibrous band almost cartilaginous in consistency which had to be sawn through to set it free. The viscus contained a big stone. The fundus was

found to be buried to about half of its circumference in the substance of the liver,

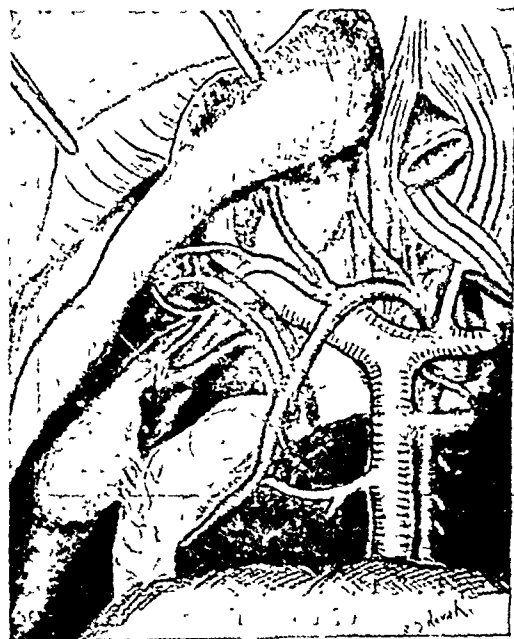


Fig. 1.

Gall-bladder fibrosed and atrophied. The fundus is slightly buried in the substance of the liver and is firmly adherent to the wall of the duodenum.

and had to be dissected out of its bed with the knife. Typhoid infection on the top of the congenital anatomical defect must have given rise to the inflammatory condition of the viscus.

Case 2. Patient, a nurse, was admitted for pain in the epigastrium and right hypochondrium. Appendix had been removed some time before with temporary relief. The attacks of pain were intermittent and spasmodic in character, with tenderness over the gall bladder region. On opening the abdomen the gall bladder was found to be free from adhesions and normal in colour and appearance, but was small in size lying parallel to the anterior margin of the liver, with some portion of the fundus lying

buried in the substance of the liver. The gall bladder was not removed as it did not show any signs of damage. In this case superimposition of some infection on top of this anatomical abnormality is sure to give rise to pathological condition of the gall bladder.

(II) *Absence of the Cystic Duct.*—Case 3. (Fig. 2.) In this case the fundus of the gall bladder was found to open into the common bile duct directly and the cystic duct was found to be absent. The patient was admitted for jaundice and persistent abdominal pain of over six years' duration. On opening the abdomen the gall bladder was found to be enormously enlarged,



Fig. 2.

An enlarged gall-bladder full of adhesions and directly communicating with the common bile duct without the regular cystic duct being present.

fibrosed, thickened and with a portion of its fundus buried in the substance of the liver. The cystic duct was absent and the fundus was directly opening into the common bile duct. The whole gall bladder, which contained three stones was removed. But a small portion of the wall which was buried inside the substance of the liver and was firmly fixed in it was left behind. The

patient died on the 12th day of the operation. Leaving behind a portion of the septic wall of the gall bladder gave rise to pyelephlebitis which caused his death.

(III) *Abnormally narrow lumen of both the Cystic and Common Bile Ducts.*—Case 4. Patient aged 25, came with a history of abdominal pain on the left side of the umbilicus with belching and intermittent pain in the cardiac region. Trouble started with cardiac pain followed by dyspeptic symptoms. Cholecystography showed defective filling. On opening the abdomen the gall bladder was found to be free from adhesions and practically normal in appearance. But the cystic and common bile ducts were found to be extremely narrow. The gall bladder was removed as it has been found that removal of the gall bladder causes gradual enlargement of the lumen of the common bile duct. The cardiac pain completely disappeared soon after the operation and the dyspeptic symptoms went on improving gradually. When seen in July 1947, (eight years after the operation), the patient was practically free from his distressing abdominal symptoms and his digestive power was gradually getting better.

(IV) *An abnormal branch of the Hepatic Artery* passing through the fundus of the gall bladder giving rise to its pathological condition. Many varieties of abnormalities have been mentioned in arteries supplying the gall bladder and the liver. According to Reginald Jackson in 20 per cent of cases the blood supply of the right hepatic lobe comes directly from the superior mesenteric artery and this hepatic branch may meander so far as to lie across the cystic duct. If mistakenly ligated high temperature and death may follow. In some cases the right hepatic artery runs parallel to the cystic duct and then arches behind it, at the neck of the gall bladder to enter the right lobe of the liver. Before doing so it gives off the cystic artery. Many other abnormal courses of the cystic artery have been noted.

In Case 5 (Fig. 3), the cystic artery normal; but an abnormal : of

right hepatic artery ran parallel to it and passing along the wall of the gall bladder, terminated in the right lobe of the liver. The gall bladder was very much atrophied with its walls fibrosed and thickened. It was impossible to set the artery free from the walls of the gall bladder, as it was

Many other anatomical abnormalities of the gall bladder such as (i) floating gall bladder (ii) double gall bladder arising from supernumerary pockets from bile ducts, (iii) bilocular gall bladder, have been described, which may be the congenital etiological factors in causing a pathological condition.

#### PHYSIOLOGICAL ABNORMALITIES

It need not be emphasized that more attention should be paid to the normal and abnormal working of the nervous system as etiological factors, in the pathological conditions of the gall bladder and the duodenum. The bile stream is subjected to the following influences:—(1) The secretory pressure of the liver. (2) Contractility and storage function of the gall bladder. (3) The collum cysticum located within the neck of the gall bladder. (4) Valves of Heister within the cystic duct. (5) Respiratory effects on intra-abdominal pressure. (6) Sphincter of Oddi. (7) Duodenal tonus and motility.

The extra-hepatic biliary system has a double nerve supply, parasympathetic fibres from the vagus nerve and sympathetic fibres from the splanchnic nerves. A controversy still remains unsettled as to which of the two carries motor and which inhibitory impulses. The most plausible explanation seems to be that for rhythmic movements of the musculature of the viscera a systematic co-ordination in working should exist between the sympathetic and parasympathetic nervous systems; most probably the sympathetic nerves control the working of the vagus nerve.

When the gall bladder contracts the sphincter of Oddi is relaxed. The maximal intra-gall-bladder pressure does not exceed the secretory pressure of the liver, thereby permitting a free flow of hepatic bile into the gall bladder, which occurs during the fasting period when the sphincter is closed. With the first meal containing a stimulus for the gall bladder contraction, the sphincter relaxes and the intraductal pressure

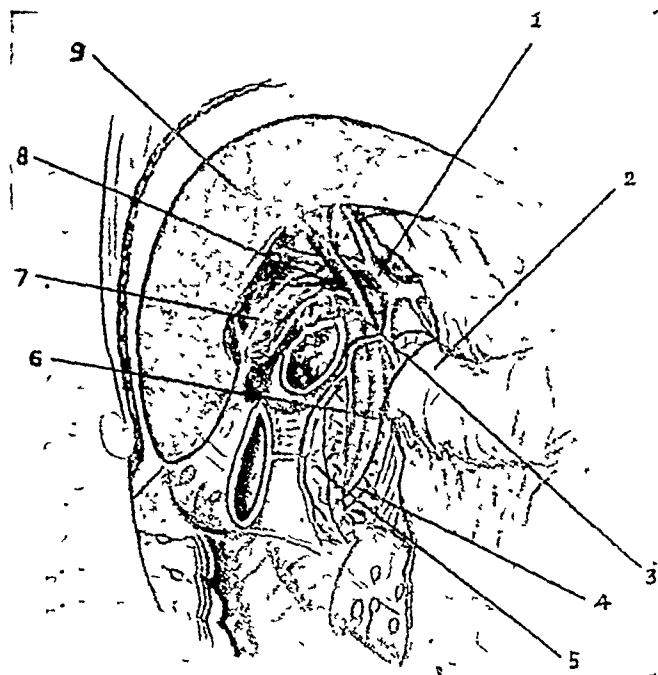


FIG. 3.

Gall-bladder is atrophied, coat is thickened and changed in colour. The aberrant artery is shown as a branch of the right hepatic artery going along the wall of the gall-bladder and entering the right lobe of the liver: (1) hepatic artery, (2) pylorus, (3) cystic duct, (4) pancreatic duct, (5) pancreas, (6) common bile duct, (7) aberrant branch of hepatic artery, (8) cystic artery, (9) liver.

firmly adherent to it. It was ligated and cut and the gall bladder removed. The patient who was suffering from severe abdominal pain for over six years was completely free from the symptoms. Apparently the right lobe of the liver was not deprived of its blood supply, by the ligation of the vessel and the artery must have been an accessory branch from the right hepatic artery, as the patient was seen in perfect health one year after the operation.



falls to a level, against which the gall bladder can now easily contract and evacuate itself either by reflex or the same factor which makes the sphincter open itself. The normal physiological stimulus for the evacuation of the gall bladder, is the passage of gastric chyme following the ingestion of fat or protein into the duodenum.

The exact pathways which carry the nervous impulses of this mechanism are not known, as yet. They certainly participate in the general balance or imbalance of the vegetative nervous system as a whole. Any vegetative function depends upon the antagonistic action of the sympathetic and parasympathetic impulses (Rothlm). The autonomic nervous system is governed by the higher centres of the central nervous system.

Thus in the pathological conditions of the gastro-duodenal area or gall-bladder, the vegetative nervous system, influencing the working of the sympathetic and parasympathetic nerves through psychic impulses, plays a very important role. Both these nerves start the process of digestion, by their control over the motor and secretory functions of the gastroduodenal and biliary systems. This process is known as the duodenal reflex. Various theories have been put forward about the working of this reflex and various descriptions given. There is no doubt that dysfunction of this important reflex is a very important etiological factor in the pathological condition of the gastro-duodenal area like peptic ulcer, and of the biliary system especially cholecystitis. The stimulation of the vagus by psychic impulses (through the vegetative nervous system) or food, stimulates the glands (secretory) of the stomach and the liver, causing secretion of hydrochloric acid in the stomach and bile in the liver cells. At the same time the motor fibres cause the rhythmic contraction of the pyloric sphincter and fundus of the gall bladder and relaxation of Oddi's sphincter, thus pumping the bile into the duodenum. For the normal process of digestion a properly

functioning duodenal reflex is essential. The duodenal reflex is disturbed by (1) Dysfunction of the vagus due to poisons such as pilocarpine, physostigmine, nicotine, and toxins such as *B. typhosus*, *B. coli*, streptococcus, etc. or faults in diet as regards time and quality. (2) Dysfunction of the vegetative nervous system due to psychic disturbances such as anxiety, worry, *néurosis*, etc.

Westphal blames the dysfunction of the vegetative nervous system. Gundermann suggests that excitement such as anger or emotional upsets might act as a cause. He located disorders of this nature in the region of the third ventricle of the brain. These emotional crises act on the vegetative nervous system according to him. Functional and organic changes chiefly in the hypothalamic region of the brain undoubtedly influence secretory activities in the epithelial cells of the gall bladder and gastroduodenal mucous membrane, probably largely through alterations in the vasomotor control. The exact mechanism by which attacks of hormonally excited neurogenic dysfunction associated with emotional upsets causes the walls of the undamaged gall bladder to absorb bile acids, selectively, and at the same time to secrete a pathological mucoid substance has not been demonstrated.

According to Brainbridge and Dole, the nervous pathways which carry the nervous impulses of the biliary mechanism participate in the general balance of the vegetative nervous system as a whole. Any vegetative function depends on the antagonistic action of the sympathetic and parasympathetic impulses. The autonomous system is governed by the higher centres of the central nervous system. The liver is, in addition to producing digestive secretions, the organ through which most of the products of digestion pass before reaching other tissues of the body. In this capacity it can be considered as a filter of the blood that has passed through the organs that have to do with the digestion and absorption of a large percentage of the food sub-

stances that enter the body. The pathway between the gastro-intestinal tract and the liver is the portal circulation. All the blood in the gastro-intestinal tract, spleen and pancreas, except the small amount that drains through the collateral channels passes through the liver. The portal circulation is therefore of considerable importance, not only in consideration of co-ordination of functions of the gastro-intestinal tract, and the liver, but also in relation to the development of pathological conditions in the two organs. Beginning in the foetal life many of the substances that reach the other tissues of the body must pass through the liver.

Infection through the hepatic artery is rare; but it is more common through the portal vein and lymphatics. In cholecystitis there is associated inflammation of the liver (in the interlobular sheaths—pericholangitis), the right lobe being more affected near the gall bladder. In the majority of cases cholecystitis represents intra-mural infection from a liver already inflamed in the interlobular and periportal tissues through infection brought by the portal vein. There is well recognized association of biliary tract infection with the lesion of portal system—appendicitis, peptic ulcer, etc. The liver being a bacterial filter where poisons are dealt with the sequence of events will be (1) infection of liver cells, (2) destruction of parenchyma and infection of bile & (3) infection of gall bladder through blood vessels, lymphatics or direct contact. In the portal system there are two streams, one derived from the alimentary canal, and the other from the spleen. The organisms from the blood are arrested by the mesenteric glands and the epithelium of the liver sinuses. Destruction of the organisms by the Kupfer's cells leads to filling up of the perivascular spaces with leucocytes and finally hepatitis. The organisms within the portal current may be derived from the spleen. The association of the diseases of the liver and of gall stones with diseases which seem to have their origin or chief development in the

spleen has recently become clearer. In haemolytic jaundice 60% suffer from cholelithiasis. With splenic anaemia both cirrhosis of liver and gall stones are associated. In cholelithiasis the spleen is found enlarged. It is from the spleen that the infection is derived. Splenectomy for recurrent cholelithiasis may be found necessary, when the bile ducts (including those in the liver), are filled with mud and fine stones. One of the functions of the spleen is to filter out micro-organisms and toxic substances from the blood stream and send them to the liver for destruction. Stones especially calcium bilirubin ones owe their origin to increased destruction of red cells in the spleen.

#### CHOLESTEROL METABOLISM

The disturbances in the metabolism are:—  
(1) Cholesterosis of gall bladder. The papillae of the viscus are laden with cholesterol esters. This is not an infective condition. Cholesterol is held in bile just as urea in urine. (2) Cholesterol increases in blood in pregnancy, post-infectious states, nephritis, and hepatic diseases.

Four factors (1) congenital anatomical abnormalities, (2) metabolic disturbances, (3) infection and (4) biliary stasis due to disturbed physiological function, especially neurogenic in origin, are of primary importance in the development of cholecystitis and cholelithiasis. Mere disturbance in cholesterol metabolism acting by itself would give rise to strawberry gall bladder which is now supposed to be a noninflammatory condition. An infected gall bladder containing *B. Typhosus* or *B. Coli* in the bile, may not show any signs of cholecystitis. So also stasis of bile due to spasm of the sphincters or gall bladder muscle caused by nervous (vagus) disturbances, may give rise to occasional abdominal pain, such as 'biliary dyskinesia' of Westphal, without any inflammatory condition of the gall bladder being present.

These four, especially two factors viz. (i) biliary stasis and (ii) infection are found in the majority of cases to be the

most common factors in the etiology of cholecystitis. Where stones are present cholesterol metabolism also plays an important role. Congenital anatomical abnormalities are naturally found in a few cases. In any case mere infection would not give rise to a pathological condition of the gall bladder unless damage already exists in the wall of the viscus, due to one of the above factors. Moreover the pathological changes are mainly intramural, as the infection is mainly haematogenous and the walls of the gall bladder have a rich blood supply.

Wolfer has proved that under certain circumstances pancreatic juice in man could and does pass by reflex into the gall bladder and cause pathological changes which vary from oedema to complex necrosis of the walls.

#### THE THYROID AND GALL BLADDER DISEASE

Hinton reviewed 43 cases of hypothyroidism which presented typical symptoms of peptic ulcer. Rigel, Ravdin, and Morrisson, noted that thyroid disorders are frequently associated with gall bladder disease. A high cholesterol level is found in both gall bladder disease and hypothyroidism. Epstein and Gainsborough and others have noted an inverse relationship between thyroid function and blood cholesterol level and many believe that blood cholesterol level is a more accurate index of thyroid function than the basal metabolic rate. Both hypothyroidism and cholelithiasis are much more common in females and both diseases are associated with obesity. Many patients with gall bladder disease present typical picture of hypothyroidism especially females, whose thyroid is apt to be depleted during pregnancy and with the onset of menopause, a time when gall stones occur. In thyroidectomized animals the gall bladders were found to be distended, the bile contained in it was found to be thick, and viscid, with large amount of thick brown precipitate. Some of these gall bladders contained numerous black concretions in them consisting of traces of calcium and cholesterol. Hypercholester-

laemia is found to develop in thyroidectomized animals and is present in cholecystitis. Thyroid extract or a normally functioning thyroid gland is essential for normal gall bladder activity. Digestive complaints such as nausea, epigastric pain, and constipation are associated both with hypothyroidism and chronic cholecystitis. Both diseases show a basal metabolism rate of — 10 or below.

Many a time it is found that a person who has had no regular attack of amoebic dysentery develops an amoebic abscess of the liver. It has been proved that this is due to the patient being infected with amoebae, which have not given rise to any pathological symptoms of colitis, the infection being an incipient one. Similarly typhoid bacilli which are responsible for the infection of the gall bladder in a fairly large number of cases, may give rise to cholecystitis in a patient, who does not give any history of a regular attack of typhoid fever. The following is a case of this type.

Case 6. B. aged about 16. Male. Patient came for constant pain and tenderness in the gall bladder area, well marked debility; distension after meals and loss of appetite. Joint pains and sensation of pins and needles in the roots of the hair of the head present. About two years back the patient developed slight fever for four days which stopped but was followed by severe jaundice with vomiting and abdominal pain. The jaundice disappeared with treatment but the symptoms given above continued. About the time that he got this attack there were about two or three cases of severe typhoid in the family. Most probably the patient himself got infected by the typhoid bacilli without showing any classical symptoms of typhoid fever—the attack being an incipient one—and the bacilli got lodged in the biliary apparatus giving rise to an attack of cholecystitis.

#### DIABETES AND GALL-STONES

Says Roberts, "apparently more diabetic patients have gall stones than non-diabetic patients. All investigators are agreed that

diabetes when it occurs follows the presence of gall stones, but none has proposed that diabetes causes them to form or that the two diseases have a common cause. In nearly every case of cholecystitis the appendix is found to be pathological and it is desirable to remove the appendix when the gall bladder is being removed for its pathological condition. Many a time the appendicular symptoms are so much prominent that they manage to mask the pathological condition of the gall bladder and a wrong diagnosis follows. In the book "Inter-relation of abdominal disease" by the Hungarian doctor Elemer Fourai, Hurst says in the foreword "There has been in the past too much tendency to regard the many diseases of the abdominal viscera as isolated phenomena. Derangement of one has far reaching effects on the others. It is for this reason among others that the removal of a pathological appendix, except for acute attacks often leads to little or no improvement in the patient's condition. Some physicians doubt whether such a condition 'appendicular dyspepsia' really exists. The fact that an appendicectomy scar is one of the commonest physical signs of chronic cholecystitis is not so much an indication that a wrong diagnosis has been made in the first instance, as that the case has been judged from a too narrow point of view".

Herein are quoted two cases in which badly affected appendices were removed under the impression that they were responsible for the symptoms resembling those of cholecystitis, but the symptoms still persisted, as they were really cases of cholecystitis.

Case 7. K. Age 42. Patient was brought by a medical man for abdominal pain of some years' duration. Pain was most marked in the epigastric and umbilical regions and accompanied by nausea and well marked dyspepsia. Tenderness was present in both appendicular and gall bladder areas although it was more marked in the appendicular area. The doctor at first hesitated to show me the skiagrams which he had with him before I gave my

diagnosis, but I took them and found the shadow of a typically pathological appendix. The doctor himself was suspicious of cholecystitis and did not want me to be prejudiced in favour of appendicitis, by seeing the skiagram before examining the patient clinically. But the marked tenderness and the shadow of a pathological appendix made me think that it was a definite case of appendicitis and the gall bladder symptoms were secondary to appendicitis. So I removed the appendix which was found to be thick and fibrosed. At the same time I warned the patient that if the gall bladder symptoms did not disappear a second operation might be necessary. The patient was free from symptoms of pain for over four years, although he used to complain of sensation of retching and discomfort in the epigastrium off and on. After that he started getting more severe pain in the gall bladder area with marked distension. I advised him to have his gall bladder removed. But he has not so far submitted to the operation. In this case the skiagram of a pathological appendix and the well marked tenderness in the appendicular area made me think that the gall bladder symptoms were secondary to the appendicular condition. In fact both the gall bladder and appendix ought to have been removed at the same time.

Case 8. G. Age 24. Patient came for chronic abdominal pain with distension of some years duration. Tenderness was present both in the gall bladder and appendicular areas. In this case also the skiagram which the patient had brought with him showed a very pathological appendix, which was found lying coiled up. The appendix was removed and the patient was found to be free from symptoms for about a year. Then he started getting pain and distress in the epigastrium. He went to the Mission hospital Wai where he was X-rayed to find out if the trouble was due to a peptic ulcer, which was excluded. He came to me again and I found that the trouble was due to cholecystitis and advised him to have his gall bladder removed. He did not get operated. He saw me about

four years later complaining of extremely severe pain in the epigastrium for which he was taking morphia every day. His doctor told me that he consulted a surgeon in the interval, who diagnosed it as a case of peptic ulcer and gastro-jejunostomy was done. Since then he has been getting extremely severe pain which has made him contract morphia habit and he has become an inveterate addict to it. He consulted some other surgeons who diagnosed it as a case of jejunal ulcer although the skiagram taken lately does not show that lesion. In this case also the skiagram of a well marked pathological appendix misled me and only appendicectomy was done while excision of both the appendix and gall bladder was indicated.

In a fairly large number of cases patients who come with typical symptoms of cholecystitis of some years' duration have been found to have a normally filling gall bladder on taking a Roentgenographic plate although clinically the patient has all the symptoms of a pathological gall bladder, and the diagnosis is confirmed at the operation table.

Case 9. The patient was seen in 1925 for an acute attack of biliary colic which was treated with remedies for gall bladder trouble and some improvement followed. But he was not seen for some years till 1932 when he came with an attack of severe cholecystitis with jaundice, fever, and pain. The skiagram showed a normally filling gall bladder. Operation was done after the acute attack subsided and a typically pathological gall bladder was removed. Since then the patient has been keeping very good health.

On the contrary in some cases the patient with all the symptoms of typical cholecystitis has an X-ray taken which shows a pathological gall bladder, but on opening the abdomen the gall bladder looks apparently normal—free from adhesions, normal in colour etc. But cholecystectomy gives complete relief to the patient. It is such cases that the position of the surgeon is rather embarrassing. Says Catell "A gall

bladder should be removed when there is a history suggesting cholecystic disease, when the cholecystograms are suspicious looking and show pathology and when other gastrointestinal diseases are ruled out." According to Verbrycke "Following cholecystectomy in 32 cases of relatively normal appearing gall bladders the end results were traced for years. A surprising percentage of satisfactory results was obtained without operative mortality. It appears perfectly possible to obtain as good results from cholecystectomy in properly chosen cases of relatively normal appearing gall bladders as in the more diseased gall bladders. The patient must be carefully studied and the operation decided upon, only after mature judgement. Symptoms and tests should correlate. If the symptoms and tests warranted an operation, and no other satisfactory cause of discomfort can be found at operation, not only is it perfectly justifiable to remove the gall bladder—even though it appears fairly normal—but excellent results may be anticipated."

Lastly increasing importance is being given to the intimate connection between the pathological condition of the gall bladder and disorders of other important viscera, especially the kidney and heart.

*Kidney.*—It has been generally believed that the liver when severely injured by disease or trauma produces a soluble toxin, which causes definite pathological changes in the kidneys. There is an increase in the blood of the non-protein nitrogen, creatinine and albumin, pus, and casts in the urine.

*Heart.*—Many times diseases of the gall bladder and coronary disease coexist. Convincing electro-cardiographic evidence of improvement at times has been observed to follow cholecystectomy. Many investigators have demonstrated reflex pathways between the gall bladder and the heart. Pain of acute coronary occlusion is often confused with pain produced by gall stones. Pain, fever, vomiting and leucocytosis are commonly met with in both conditions. But past history of indigestion is in favour of

cholecystitis. Babcock believes that inhibition of the heart can be caused by stimulation of the filaments of the vagus, arising from the walls of the gall bladder. The jaundice produced by gall bladder disease may secondarily affect the cardiac mechanism. Systolic apical murmurs have been reported by some observers appearing during pain from gall bladder focus. According to Laird, thrombosis of the coronary arteries occurred in 12% of cholecystitis cases. Cholecystectomy cured 78% of cases with gall bladder symptoms.

Taking all the above facts into consideration, it can be proved that nervous reflex—disturbance of the function of the vagus—giving rise to stasis of the bile flow due to disturbed duodenal reflex, combined with infection is the potent factor in the etiology of the pathological condition of the gall bladder. Disturbance of cholesterol metabolism and congenital anatomical abnormalities may be additional factors.

## BURNS

by MUNAWAR ALI.

(Concluded from previous issue.)

### EARLY PLASTIC TREATMENT OF THERMAL BURN

Burns could not be considered as healed until the granulating surfaces are epithelialised and the treatment could not be considered as over till complications like contractures and deformities have been corrected by plastic surgery.

*Care of granulating surfaces of thermal burn:* A patient running temperature, suffering from toxic and septic absorptions, having hypoproteinaemia, looking pale and anaemic, cannot be expected to have a granulating surface fit for grafting.

For successfully converting granulating surfaces of burns into a properly healed surface, it is imperative to pay attention to the general care of the patient. All attempts will prove futile if the soil is not fertile enough to take the graft.

To improve the general condition of the patient an adequate and well-balanced diet is essential. The daily protein requirements of such a patient is estimated to be as high as 200 to 400 grams per day. The expense and the poor appetite of such a patient have been very difficult problems. I have been successful in solving this in a small way by providing these patients with palatable, easily digestible and assimilable soup prepared by mixing serum obtained from the slaughter house blood with boiling tomato juice. In patients receiving this soup blood protein levels rose surprisingly quickly. It also helped in curing their anaemias to some extent. A haemoglobin level of about 75 per cent is essential for successful grafting. This may require repeated small blood transfusions. The problem of anaemia of thermal burn requires proper recognition and care from the early stages of burn therapy. If burn

cases are provided liberally with Vitamin C, the reparative process will be rapid.

While dealing with the thermal granulating surfaces plaster splints are used to retain the normal position. They do not prevent contractures; if applied after forcible stretching, the further damage thus created helps to lay down more scar tissue which eventually favours more contractures and deformities. The only way to prevent is by early skin grafting.

For practical purposes any burn ulcer of over 4 weeks' duration with a diameter of 2 inches or more requires skin grafting.

Grafts are taken from the patient's own skin. On rare occasions I use homogenous grafts in cases where in view of the general precarious condition of the patient it was considered advisable to convert a large raw surface into a healed surface and thus contribute to the early well-being of the patient. These homo-grafts from other individuals often take successfully but are destroyed by the recipient's body in the course of about 2 or 3 months. By the time this occurs the patient's condition will be improved sufficiently enough and he will be fit to undergo proper plastic repair from autogenous grafts. It is interesting to mention here that in our institution in some cases temporary covering of raw surfaces was obtained by using easily available homo-grafts from preputial skins of circumcised boys.

I have practically given up using small deep needle grafts (Reverdin's graft, Davis' graft, Pinch graft—this traumatic and damaging method was practised at one time and is now condemned), because when this

method is used the end result of both recipient and donor area is like crocodile skin—ugly and distasteful indeed.

In dealing with rare granulating surfaces specially in a patient who has had a stormy period of toxæmia and infection and in whom rapid and early healing is essential from the point of view of the patient's general condition and where in spite of the adoption of usual procedures some septic discharge persists, I have used small pieces cut from a sheet of split graft and embedded them under the granulating surface, hidden from the naked eye, covered with vaseline tulle and saline soaked gauze pads—the last-mentioned being changed daily. From these embedded grafts whitish islets of epithelium grow and gradually spread over the raw surface and epithelialise the burn area.

*Preparation of the granulating surface :* If surface swab under high power shows not more than 2 to 3 organisms per field such a surface is bacteriologically considered fit for grafting. However the suitable surface for grafting is more adequately judged by its clinical appearance. With some experience this can be well relied upon. The granulations should be healthy, clean and of good colour. Neither the granulations nor the surrounding area should be oedematous. In case of oedema attention should be paid to deal with hypoproteinaemia. Granulations should be on the same level as the surrounding skin. Antiseptics and greasy dressings are abandoned at least 24 hours prior to skin grafting. Skin grafts do not take well on greasy surfaces. During this pre-operative period saline soaks are used.

Granulations over 12 weeks are shaved off with a razor before grafting. Hot saline compress and firm bandage are applied. To avoid carrying sepsis gloves are changed before going over to the donor site for grafts.

*Donor Site :* It is selected remote from the raw surface. This is necessary to prevent infection of the donor site from the burn wound. Areas considered suitable for future pedicle grafts are left over. The convex surface of the thigh is ideal for the razor graft. Concave and irregular surfaces can also be used if Padget dermatome is employed.

The area from where the graft is taken is temporarily outlined with a fountain pen. Tincture of Iodine is applied. Half to one per cent Novocaine solution, without Adrenaline, is used for infiltration anaesthesia. All needle punctures start on the outline and these puncture marks serve as guides to cut grafts within these limits.

Intermediate split skin grafts of the Blair type are preferred, because of the small amount of scarring that occurs underneath these grafts and for their good appearance and lack of pigmentation and their ability to bear pressure moderately. Superficial epidermic grafts of Ollier-Theirsch variety are not used nowadays because they do not prevent sub-epithelial scarring, often show pigmentation, although they require less attention and the take is successful on even less cleaner surfaces.

For cutting split grafts the skin is held tight between two pieces cut from each end of a coathanger. With a very sharp razor the grafts are cut towards the operator, with flexed and fixed elbow and moving shoulder. These grafts are temporarily transferred to a tray containing warm normal saline.

After the removal of such grafts the donor surface should be a field of multiple minute bleeding points. The site should heal without scarring and be available for further use for taking grafts in about 4 to 6 weeks' time.

The donor site is dressed, with cod liver oil gauze, and a few layers of vaseline



gauze, covered in turn with a few more layers of dry gauze, thin cotton padding, and the whole is fastened with elastoplast. This dressing is removed between 11 and 14 days by which time the surface is probably healed.

*Grafting the Burn:* Before applying grafts on to the recipient area, they are fenestrated with sharp pointed scissors, nicks one inch apart, for the exit of exudate, should any occur. They are transferred with the aid of a shovel and applied with the aid of two dissecting forceps. No air, serous discharge, or fine blood clots are left underneath the graft. Grafts may be anchored to the edges with fine cotton stitches avoiding catgut as the latter excites tissue reaction. In the case of shaved granulation surfaces a few stitches across the graft as well are essential.

Thin and even frosting with penicillin of burn surfaces before laying the graft and parenteral administration of penicillin have decreased the number of failures specially those due to infection.

Dressing of the grafted area is a very important step indeed, requiring great skill and meticulous care on the part of the operator. This is best not left to juniors. A simple yet most useful first covering is perforated cellophane paper or perforated oiled silk. Over this is laid cod liver oil gauze, a few layers of vaseline gauze, a layer of cotton wool and finally sterilised mechanic's waste. In place of plain cotton, in cases where some discharge is expected, it is preferable to apply cotton soaked in acriflavine and paraffin. Dressing is held by firm elastic bandaging. Slipping of the dressing is prevented by adhesive elastoplast applied so as to anchor the dressing to

the surrounding skin. Where movement is liable to interfere plaster slab splintage is used for adequate immobilisation.

On the third day I prefer to open the dressing only down to the vaseline layer for inspection. If dry, superficial dressing is changed; if there is any discharge complete change is done, taking care that there is no pulling off, or disturbance, to the graft in the slightest degree. I do not soak the dressing before changing.

Rechanging is done as infrequently as is feasible, depending upon the amount of discharge.

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## PLASTIC REPAIR OF THE BURN CONTRACTURES AND DEFORMITIES

There are not a few patients who no doubt have survived the accident of burns, but wish they were among the fatalities, because they have been left with ugly scars, unsightly contractures and deformities, and in many instances with the resulting crippling disabilities. Such gross deformities which more or less cripple the individual, are so commonly met with in this country that they are not only an important medical problem but a social and economic problem too. What a valuable service it is to convert these individuals into useful citizens!

There are other instances where the condition is not so bad. Wounds of the deep burn might have healed with dense scars only to break down after some time due to occupational strain, ordinary trauma, or circulatory disturbances and persist for years as chronic ulcers in the centre of large healed scars. Such a patient loses body fluids, proteins, and blood over a number of years and becomes debilitated and anaemic, and runs the risk of malignant change not infrequently, with its disastrous effect to health and later to life.

It is of vital importance to appreciate that no burn case can be considered cured until complete and permanent restoration of normal physiological functions of the areas of the body involved in the accident are obtained.

In correcting these contractures and deformities it is worthwhile keeping in mind that when healed scar tissue contracts, it produces primary contractures. As time passes on, underlying structures—fasciae, tendons and even muscles, vessels and nerves, and later capsules of the joint become contracted secondarily, and lead to deformities, with fixation of the joints.

It is sometimes not possible to assess the exact nature of the involvement until the dissection proceeds to the depth. Excision of the scar tissue is performed till good, soft and vascular tissue appears. In the deeper

dissection particularly one has to be very careful in doing no further damage to the already damaged area. Deformities are corrected with necessary surgical procedure slowly and patiently. This sometimes may require many operative sittings. Forcible correction might lead to regrettable results due to impairment of vascular supply, and consequent sloughing and death of an already traumatized tissue.

As in all other plastic repairs efforts are made to preserve and utilise all the locally available tissue by correct planning and proper execution.

Most of the resulting raw surfaces can be covered with split skin graft with good functional and cosmetic results. However, I prefer full thickness skin through pedicled flaps in situations like, the dorsum of the knee and ankle joints, heel and most of the palmar surfaces and dorsum of the hand, occasionally in front and below the shoulder joint and in front of the elbow, because in these regions they stand the occupational trauma and strain better. The only draw-back is that they require multiple operations and longer surgical care.

Free full thickness grafts are only used to cover small fresh raw surfaces in regions where otherwise pedicled flaps would have been required.

*Regional Repair:* If any of the patients brought for late plastic repair of burn has any raw surface left over, it is covered with Theirsch graft and allowed to heal before definitive treatment is started. This provides a clean surface free from infection for the plastic operation.

*Hand:* In my experience when a great part of palmar skin is lost, and the dissection for correction of the deformities has gone deep enough, and the tendons have been lengthened, abdominal skin through a pedicled flap, though a little laborious, provides the ideal covering. Subcutaneous fat gives a good covering to the exposed ten-



Fig. 8-a



Fig. 8-b



Fig. 8-c



Fig. 8-d

Fig. 8-a Shows deformity of the right hand due to burn when the patient was a baby. Fig. 8-b Abdominal pedicle graft transplanted to the wrist. Fig. 8-c further correction of deformity and spreading of the graft over the palm and finger. Fig. 8-d End result with a hand of good functional value and appearance.

dons and something like a new synovial sheath soon forms underneath this skin.

Fig. 8-a: On admission this little boy had a peculiar flexion deformity of the fingers and thumb. The thumb was completely folded and embedded in front of the wrist in a mass of scar tissue. The index finger was straight and immobile, middle and ring fingers badly contracted, and the little finger rigid and adducted to a right angle. This boy's hand was severely burned when only a baby, a few months old.

In many stages, by very careful excision of the scar tissue preserving all the structures, by elongation of tendons, by vessels and nerves being allowed to stretch, by restoring some of the inter-phalangeal joints by interposing tissues between bones, the thumb and fingers were gradually straightened.

Fig. 8-b: Abdominal pedicle was transplanted over the wrist area.

Fig. 8-c: Further release of the thumb and fingers, and graft spread over palmar and digital areas.

Fig. 8-d: Finally a hand with satisfactory function and good appearance was obtained.

Fig. 9-a: Shows a boy who had, a year ago, deep burns of the palmar side of the right hand, which had resulted in excessive scarring and contractures of the fingers and adduction deformity of the thumb. He was discharged from service as permanently unfit.

The scar was dissected layer by layer, thumb partly released, fingers straightened and passed through a tunnel of skin in the thigh. After the graft had taken, the hand was released and the webbing of the fingers corrected.

At the final sitting I make it a point to excise from underneath the newly grafted skin subcutaneous fat only along the side to give the finger its rounded contour, and leave the central strip of fat in front of the flexor tendons.

Fig. 9-b: Shows the end result after a few months with function completely restored, the grafted skin having adapted itself indistinguishably from natural palmar skin.

Fig. 10-a: A girl with severe scarring and contracture deformity of index and ring finger of right hand. After a difficult excision of keloid carefully performed it was embedded in the thigh with fingers spread apart.



Fig. 9-a

Fig. 9-a Contracture deformity of the fingers corrected, fingers and the forepart of the palm embedded in the thigh. Fig. 9-b Satisfactory end result.



Fig. 9-b

## BURNS



Fig. 10-a



Fig. 10-b

Fig. 10-a Contracture deformity of the fingers corrected and fingers embedded in the thigh. Fingers are kept wide apart. Fig. 10-b Shows a satisfactory result. The grafted skin has started showing signs of adaptability.



Fig. 11-a



Fig. 11-b

Fig. 11-a A boy who has sustained very extensive deep burn. While still under treatment for granulating surface in order to prevent the contracture deformities of the hand it has been transplanted in the left thigh; graft has taken and is even showing signs of adaptability.

Fig. 11-b Same boy with a useful hand with slight contracture at the wrist for which treatment was refused.



Fig. 12

Fig 12-a

Fig. 12-b

Fig. 12 Shows the result of such a modified Y-plasty. (Perhaps more accurately to be called S-plasty.)  
 Figs. 12 a & b Represent diagrammatically wavy incisions for the correction of the arm-trunk adhesions.



Fig. 13-a

Fig 13-a Shows a dense adhesion.



Fig. 13-b

Fig. 13-b Scapular and pectoral flaps have been used under the axilla for correcting adhesion.

Fig. 10-b: The same girl six weeks after with fair cosmetic and functional result.

Fig. 11-a: Shows a little boy with very extensive burn of mixed type, who had passed through a critical period of shock, toxæmia and infection. In this case I had violated the usual principles of plastic repair. Having guessed, as I later found myself to be correct, that when the deep burn wound healed completely by scarring, the mother will not permit me to repair the hand, as she had already refused simple grafting, I embedded the palm and base of the fingers of the left hand in a tunnel of the skin of the thigh—not far from the unhealed septic burn area.

Fig. 11-b: Shows the boy with a completely good palm and fingers. Slight abduction deformity due to scarring which could not be corrected as permission was not forthcoming.

*Axilla, Trunk and Arms:* The commonest deformities met with in this region is the arm united to the trunk by means of a web or dense scar tissue with or without sinuses leading to axilla. The web condition is often quite easily amenable to single or double ordinary or reversed Z-plasty, with the utilisation and suture of anterior pectoral and posterior scapular flaps.

In case there is considerable scar tissue wavy incisions and multiple short flap repair is sound in principle and often sur-

prisingly successful. In this way sloughing of the sharp pointed ends of the flaps of Z-plasty is avoided.

Fig. 12: Represents the end result of such a repair with complete restoration of the movements of the shoulder joint.

In case of dense adhesion in this region, (Fig. 13-a) I prefer thick scapular and pectoral flaps to cover the raw, uneven surface of the axilla after dissection and correction of the deformity. The remaining rough and uneven raw surfaces are allowed to smoothen out with new healthy granulation tissue before split grafts are applied.

Fig. 13-b: Shows pedicled flaps having taken and united under the axilla and the raw surface smooth and ready for split grafting.

*Cubital and Popliteal Areas and the Leg:* In the antecubital fossa occasional web like scar can easily be corrected by Z-plasty. Others may require thick grafts. However, in cases where scarring is deep I prefer pedicled graft for good function.

In the popliteal fossa to meet the demand of the strain of squatting I only use pedicled flap skin.

Fig. 14-a: Shows a chronic burn ulcer in the middle of a fibrous scar that has resulted in ankylosis of the right knee. This ulcer had persisted over a number of years, and probably would never have healed spontaneously.



Fig. 14-a



Fig. 14-b

Fig. 14-a. Shows the ankylosed right knee with scarring and ulceration.  
Fig. 14-b. Left knee ankylosed with excessive scarring and contracture deformity.



Fig. 14-c

14-c. Shows the end result after pedicle and split graft repair.

Fig. 14-b: The left leg was in a worse condition of ankylosis at the knee as a result of contractures of deep structures and a massive scar tissue. As a result of this deformity the patient had taken to begging. With great difficulty she was persuaded to undergo operative repair. While excision of scar and ulcer on the right side was possible in one stage, correction of the deformity on the left side was only possible in three laborious operative sittings, requiring excision of the scar, fasciotomy, tenotomies in stages, lengthening of contracted vessels, neurolysis, and finally capsulotomy by criss-cross incisions and stretching. Whole thickness skin from abdominal pedicled flap caterpillared to the wrist were grafted on the back of the knee and the remaining area was grafted with split graft. Nearly six months after, having remained a cripple for some years the patient was able to stand and walk. I sincerely hope she has kept up her promise and changed from begging to some useful occupation in the village.



Fig. 15-a

Fig. 15-a Shows a massive abdominal pedicle grafted to the healthy leg.

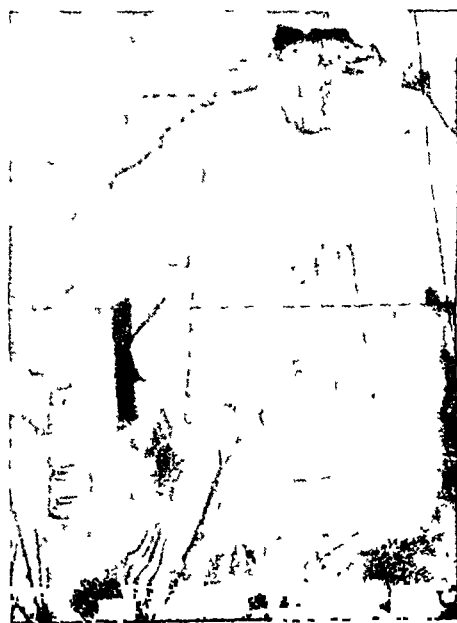


Fig. 15-b

Fig. 15-b After correction of the deformity pedicle is grafted over the dorsum of the left foot



For bare-footed people and farmers to stand the strain of occupational trauma I prefer pedicled flap in front of the ankle and lower leg.

Fig. 15-a: Shows a healed infected burn on the dorsum of the left foot and leg with severe contracture and dense scar in which the second, third, fourth and fifth toes were involved and partially buried. Excessive keloid formation and piling up of keratin were present. The foot was bound up in full dorsiflexion without any movements at the ankle. The patient could with great difficulty walk short hops over the left heel. After some years he came under my care, having been refused marriage until he was cured, fit and respectable looking.

A massive long abdominal pedicle has been transplanted to the right leg.

Fig. 15-b: After excision of keloid and scar tissue, and lengthening of tendons, abdominal skin has been grafted. At a later stage remaining scar was excised and the pedicle completely flattened out. Unfortunately for me the patient was so happy about his appearance and so anxious for his marriage that he left without saying goodbye to me, and robbed me of the pleasure of the final clinical photograph.

Burn ulcer scars on the heel are so liable to malignancy that an early excision is imperative. Whole thickness pedicled flap with as much amount of fat as available serves the purpose—but unfortunately not quite satisfactorily for weight bearing purposes among the barefooted farmers and villagers.

*Head and Neck:* On the scalp raw surfaces can satisfactorily be covered by split grafts. When the area is denuded of pericranium split grafts do not take and therefore I cover it by swinging a pedicled flap from adjacent scalp area, and the new defect thus created is covered with split grafts.

On the face thick skin grafts take quickly and are satisfactory. Near about the eyelids I prefer full thickness free skin grafts.

Occasionally pedicled grafts are required. Repair on the face requires special attention in planning and execution.

On the neck Z-plasty sometimes is partially or completely satisfactory; the remaining area is grafted with deep split graft and rarely by pectoral pedicled flap.

*Genital and Perineal Region:* When the skin of the penis is lost or damaged it can be suitably repaired by baring the penis and embedding it through a scrotal tunnel.

When the damage is deeper I use bilateral abdominal pedicles for the repair. Here I would like to digress and refer to Fig. 16



Fig. 16

Fig. 16. • Shows an abdominal pedicle grafted at the ankle standing erect.

where the abdominal pedicle is standing erect on the dorsum of the foot. The accidental happening has helped me in repair of the penis in such cases. Accidental use of thick catgut suture for converting the flap into a tube gave rise to some tissue reaction and resulted in a fibrous scar which also penetrated somewhat to the depth of the tube and made it stiff. I now use purposely thick catgut subcuticularly to unite the right and left abdominal pedicles on the ventral and dorsal aspects of the penis and complete the repair by cuticular fine cotton stitches.

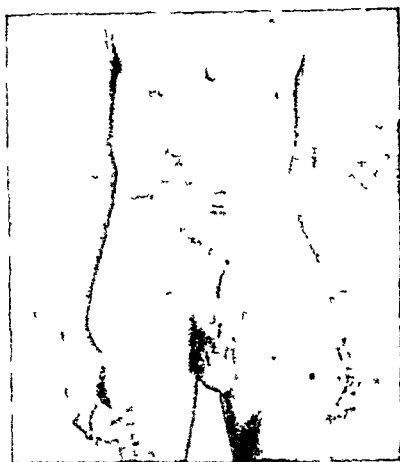


Fig. 17

Fig. 17. Shows the use of the single abdominal pedicle for clothing the penis.

In case of deep but uniform involvement of penile skin a temporary perineal urethrotomy is performed, and the penis is clothed in a single abdominal pedicle as shown in Fig. 17.

Abdominal pedicled flaps can be used with advantage in the repair of the female genitalia.

A preliminary spur colostomy is essential prior to the repair at the anal region. Pedicled flaps from gluteal region are utilised in this situation.

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## DISCUSSION.

A. de Sa described 45 cases of all degrees of burns treated at the Bai Jerbai Wadia Hospital for the three years 1944-1947.

All these cases were treated by a uniform method—a minimum debridement and cleansing with normal saline without an anaesthetic, and a subsequent compression dressing with 5% sulfa-thiazole ointment, after the method of Koch and Allen. The over all mortality in this group of cases was 14%—the large majority of deaths in this group occurring in patients who had burns involving over 20% of the body surface. The problem of sedation in these infants was an important one. Morphine was generally inadmissible in children of the age groups encountered. Intramuscular injections of paraldehyde had been found useful, but this form of therapy was contra-indicated in burns involving the chest, from the risk of pulmonary complications supervening.

Among the untoward complications that developed, were diarrhoea (11.1% of cases) which responded to the customary astringent remedies, and convulsions, which were of grave prognostic import. Of the three cases that developed convulsions, two died.

N. F. Saher: The opener has rightly pointed out the risk of repeated subcutaneous injections of morphine to the burnt subject. The intravenous use of morphine for relief of pain is not as extensively practised as it deserves. For the average patient a sixth of a grain of morphine is dissolved in two c.c. of distilled water and injected reasonably slowly into a vein; too rapid an administration may lead to unpleasant side effects like nausea, giddiness and sickness. Apart from being a more certain method of exhibiting morphine, the intravenous route is much quicker in affording relief from pain. Given subcutaneously morphine requires 60 to 90 minutes for production of maximum depressant action; this period is reduced to 10 to 20 minutes by employing the intravenous route. In exhibiting morphine and anaesthetic agents it is imperative to bear in mind that the burnt subject is an ill patient; a little goes a long way with him.

Frequently the common sites for intravenous medication are involved by the burns. In such cases the sternal route of transfusion proves of life saving value. With a special short, thick trocar and cannula either the centre of the manubrium or the body the sternum is pierced so that the anterior plate of the sternum is traversed; the trocar is withdrawn, leaving the cannula firmly held by bone. A syringe is now attached to the cannula and sternal marrow is aspirated. The transfusion tube is now attached to the cannula. Since the cannula is gripped by bone the risk of accidental displacement is reduced.

R. Mahadevan: While tannic acid treatment undoubtedly saved many lives, it was found that it

had toxic effect on the liver, which accounted for some of the deaths. Silver nitrate solutions in combination with various aniline dyes had a trial, and were found to be safer from the point of view of liver damage. Still the treatment was not all that one could wish. Simplified methods of treatment are coming into vogue and are credited with more favourable results.

1. General anaesthesia in some form is usually administered for debridement of the burnt areas. It is now realised that this is better avoided, as the anaesthetic agents were found to be responsible for some of the deaths. There is reason to believe that cases of burns have relatively little pain after the first half hour, morphia in adequate doses and repeated as found necessary is sufficient to relieve the pain.

2. All forms of cleansing excepting the removal of gross dirt may be omitted. Even for this, the area should not be scrubbed with a brush, but only cleaned up with soap and water using soft cotton swabs. In the well known "Cocoanut grove disaster" neither cleansing nor debridement of the burnt area was done. (Cope, 1943.)

3. As a part of first aid treatment, the burnt area is covered with sterile towels. *Then the surgeon scrubs up with all the scrupulous care as for a major operation, donning sterile overalls, gloves, face mask and cap. Then, and then only further attention to the burnt area begins.* This is considered by many as a very important necessity to prevent access of infection from external sources. One of the previous speakers said that infection in burns is due to the already existing organisms in the skin and not due to the infection introduced from without. This I am afraid is dangerous teaching. It is the opinion of almost all that the precautions mentioned, viz., the surgeon scrubbing up as for a major operation is a vital necessity.

4. The burnt area is dressed in one of several ways varying according to the views of the individual surgeon and the fad in vogue at different times. A good method seems to be to dust the area with a powder, consisting of sulphanilamide and light magnesium oxide to which is added calcium penicillin so as to give a strength of 1000 units per gram (Wakeley, 1945) or to apply a cream made with soft paraffin and lanette wax to which is added penicillin solution, so as to give a strength of 1000 units per gram (Wakeley, 1945). Penicillin-sulphamezathine powder has been used with gratifying results. As a first aid in small burns or when patients cannot be removed to a hospital, better than application of tannic acid jelly, is the following:—

Gentian violet	1%
Brilliant green	0.1%
Eusflavine	0.1%

to which 5% sulphadiazine is added and applied in the form of a jelly (Wakeley, 1946).

5. Shock in burns is due to escape of plasma from the circulation into the burnt areas. To combat this loss, plasma transfusion has to be instituted as early as possible. Oxygen inhalation is of great help. If plasma is not readily available, fluid loss may be replaced by one or other well known methods. The use of continuous intra-gastric drip feeds and particularly continuous intra-gastric isotonic saline may be of help and of easy adaptability in out of the way places, where more elaborate methods may not be feasible. In addition, mechanical measures to prevent escape of plasma into the burnt areas by the application of elastic bandages over the dressings (so called occlusive method) may be adopted. We have been experiencing difficulty in getting requisite elastic bandages. Moreover, it is a costly method. As an alternative, layers of aqueous flavine gauze soaked in vaseline or liquid paraffin are laid over the burns, liberally sprinkling penicillin sulphamethazine powder between the layers. Firm pressure over these is obtained by moulding plaster bandages to the area. The dressings are not changed until ten to fourteen days after the burn. This is least disturbing and therefore comfortable to the patient. The method gives gratifying results. The nutrition of the patient must be kept up by food rich in proteins, carbohydrates and vitamins, particularly vitamin C. These patients tend to become anaemic and this must be controlled by massive doses of iron and blood transfusions.

Chronic sepsis and contractures should be prevented by early skin grafting. *Skin grafts do take even in the presence of mild sepsis.* In all cases of 3rd degree burns, early skin grafting, preferably within 6 weeks, is a very important step. Some advise immediate skin grafting in complete skin loss burns.

Chronic infections resistant, to even sulphanilamide and penicillin are sometimes met with. Such infections are mainly due to *B. Coli*, *B. Proteus* and *B. Pyocyaneus*. These infections are best treated by local application of urea formic iodide (U.F.I.) (Wakeley, 1945, 1946). It is a white, water-soluble, non-toxic, non-irritant powder and can be applied locally in powder form or in solution. It is effective not only in the above infections but also acts on both aerobic and anaerobic organisms. The use of U.F.I. powder allows skin grafting to be performed right up to the anal margin even in burns of the gluteal and anal margin. (Wakeley, 1945.)

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**H. Hyderali Khan:** Burns of the whole body have been considered as fatal. The survival of the following two cases will demonstrate the possi-

bility of saving life inspite of burns of the whole surface of the body. The moral is that one should never despair.

1. **Kannala Balaiah.** This miner had burns of the complete body from the scalp to the sole of the foot. He was given stimulant, kept under an electric cradle, and saline administered. After a few days he developed considerable sepsis particularly of the abdominal wall. This was counteracted by penicillin and the patient got gradually better and was discharged from the Hospital after 45 days. Except that his ears were crumpled he was none the worse for his burns.

2. **Bansraj Kevot.** This coalcutter was admitted to Hospital for burns of the whole surface of the body. He was given saline, coramine and kept in the electric cradle. After a few days he developed sepsis. This was counteracted with sulphanilamide and Penicillin. He was discharged after 65 days. Except that he could not use his left fore-arm on account of the formation of scar tissue he was normal.

**S. B. Gadgil:** In the paper read on 'Burns', great stress has naturally been placed on paying attention to the nutrition of the patient. The patient loses weight due to loss not only of burnt tissues but also due to loss of plasma proteins brought to the burnt tissues by osmosis and lost in oedema and discharge. The method given to determine this loss of protein is too elaborate in my opinion. Determination of the weight of such a patient repeatedly while under treatment and the knowledge that he is passing sufficient amount of urine in 24 hours should be quite enough to guide us that the patient is or is not having sufficient nourishment while under our treatment and alteration of diet made if necessary.

**R. N. Dixit:** (1) Plasma transfusion was invaluable in all cases of severe burns. The cost of plasma was however prohibitive. A bottle of dried plasma giving 250 c.c. of plasma for transfusion purposes costs anything between Rs. 50 to Rs. 60. The speaker drew the attention of the Conference to a recent article appearing in the "Lancet", by the Director of Physiological Department of the Palacky University of Czechoslovakia, where denatured calf-plasma (calf-plasma from which foreign proteins likely to give rise to severe reactions were removed by precipitation with formaldehyde) was tried out successfully. He was of opinion that the Haffkine institute should investigate into the use of animal plasma as a substitute for human plasma. If this is found satisfactory, it would be a great boon to a poor country like India, where there was also a great paucity of donors.

(2) Debridement in some cases of burns was almost imperative. Thus on several occasions burns cases are brought to the Hospital after application of all types of dirty and highly infective materials, like cow-dung.

# A STUDY OF THE LONGITUDINAL ARCH OF THE FOOT

by A. K. BASU.

(Concluded from the previous issue)

## The influence of postural tone on the longitudinal arch of the foot

A series of investigations were made to determine how far the postural tone of the long muscles was responsible for the maintenance of the arch. To this tonus has been ascribed the important function of producing and maintaining the longitudinal arch by Bankart, Wiles, Keith, Wiltz, Kaplan, Crandon, Cotton and others, while the same has been denied by Whitman, Lake, Morton, R. L. Jones and others. According to Lake, the purpose of postural tone is never to withstand dead weight, but to perform the delicate action of balancing one bone upon another such as the femur on the tibia and the leg on the foot. Morton (1935) was of the same opinion. From his staticometer study, he determined that the ratio of weight distribution among the different metatarsals when a person is standing with his body weight on both feet is in the ratio of 2:1:1:1:1 and he ascribed to the evertor and invertor muscles of the foot the function of maintaining the leg in a vertical position above the astragaloid joint. R. L. Jones from his experimental study made the suggestion that the important—perhaps the chief-function—of the so-called invertor and evertor muscles is “to preserve a relative constancy in the ratio of weight distribution among the metatarsals of the foot compensating reflexly for the intrinsic and extrinsic factors which alter that ratio.”

What is postural tone? It is, according to Sherrington, a state of continuous contraction of certain skeletal muscles which are concerned with maintaining position or posture. The distribution and degree of this contraction among the various muscles of the body are related to the attitude adopted by the animal. The upright extended position of man in the animal kingdom suggests a preponderance of this tonus in the anti-gravity muscles—the physio-

logical extensors in the case of the limbs and the back muscles in the case of the trunk. This tonus is reflex in origin—the afferent impulses originate in the sense organs of the muscles themselves and to a lesser extent is re-inforced by impulses from the vestibular apparatus and the eyes. The reflex arc employed is wholly somatic, autonomic nerves are in no way involved (Wright). The exact anatomical centre for this reflex is not known but it has been seen in animal experiments that if the red nucleus and the rubrospinal tract remain intact, the posture remains normal; while sections below this nucleus and severing this tract, interfere with the normal posture in various ways, by producing conditions of decerebrate rigidity, flexor spasm in the spinal animal etc., while section of the posterior nerve roots abolishes all muscle tone and produces complete flaccidity in the muscles concerned.

Some of the characteristics of postural tone with which we will be concerned may be mentioned here.

(1) The low degree of tension that the postural muscles develop amounting approximately to only 1/5 of the contractural force. This is evident from the low metabolism of the muscles concerned (oxygen consumption and carbon dioxide output) which is only 25% higher than completely paralysed muscle (Wright). Thus the quadriceps of cats develop 6 kgm. tension when acting tonically and 30 kgm. when contracting tetanically (Wright). “Such weak action seems rather unsuited for maintaining the whole weight of the body in the absence of any static support from the skeletal structures but is obviously ideal for maintaining posture where it implies the delicate balancing of one bone upon another.” (Lake)

(2) The relative unfatiguability of the posturing muscles. It has been found that

in producing postural tone the anterior horn cells discharge impulses at a low rate of 5 to 20 per second in contra-distinction to the tetanic contraction in which impulses are discharged at the rate of 100 per second. Such slow discharge of impulses produces individual twitch response of the different fibres of the muscles at different times so that they get periods of rest between each individual contraction—the whole producing a uniform tonic tension without fatigue.

If this unfatiguability of the tonus of the postural muscles responsible for the maintenance of the arch be true, it is evident that other factors remaining the same, falling of the arch and weakness of the foot would be no more common amongst people who bear stress on their feet for prolonged periods than amongst people whose feet get long

periods of rest. Such in fact is not the case. It is found (R. L. Jones—1941) that the flattening of the arch and foot strain are more common amongst people who have to do long periods of standing as waitresses, policemen, nurses, etc. It is less common amongst people who do a lot of walking or people who carry heavy weight on them (Porters). This led Jones to enunciate the hypothesis that is in apparent contradiction to the unfatiguable character of the postural muscles—that “distress of failure of the human longitudinal arch is co-related not with the absolute value of the stress on the arch but with the temporal duration of that stress.”

To test the influence of postural tonus on the longitudinal arches of the feet, certain conditions in which it is generally accepted that the tonus becomes diminished were

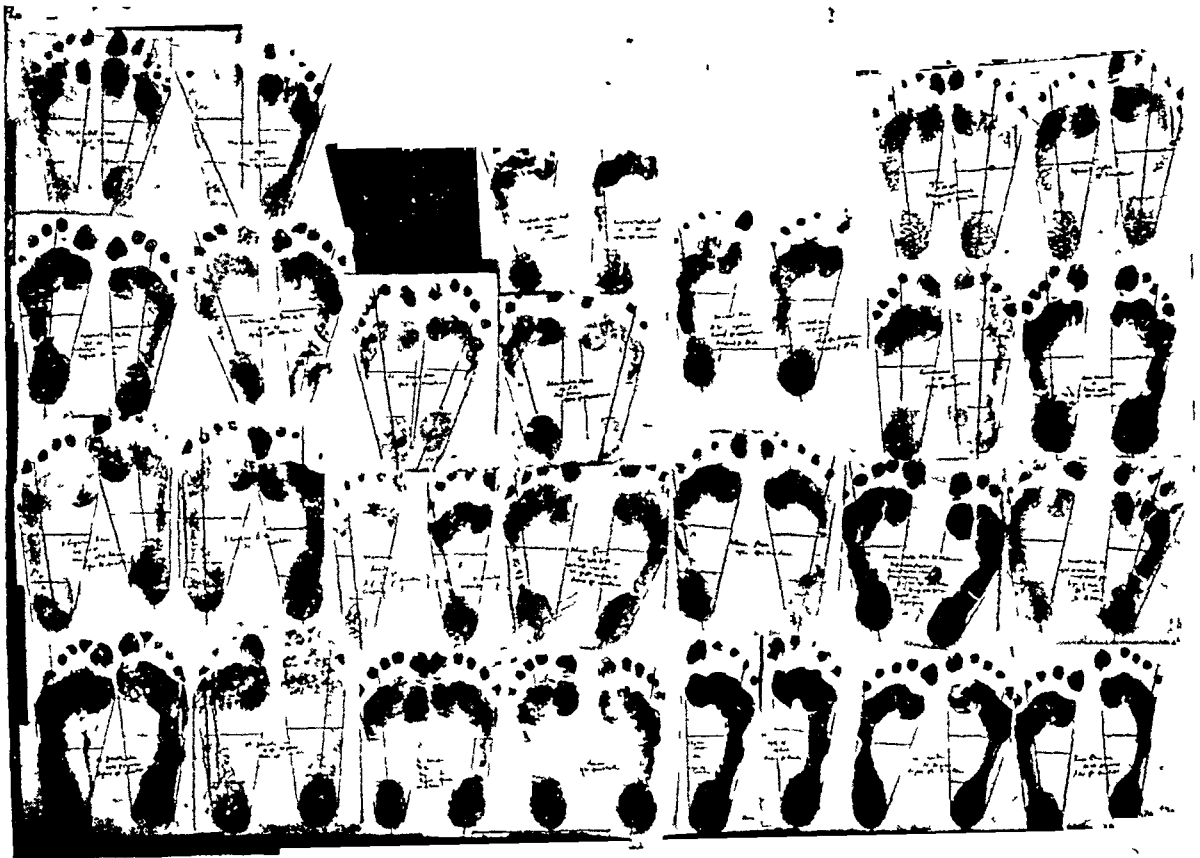


Fig. 11.

Foot-prints before and after spinal anaesthesia.

TABLE III

No.	Name	Age	Disease	Before Spinal Anaesthesia		After Anaesthesia	
				Arch Fraction	Degree of Abduction	Arch Fraction	Degree of Abduction
1.	Mitail Shaw	21	Strangulated Hernia	Rt = .21 Lt = .19	Rt = 2D Lt = N	Rt = .28 Lt = .21	Rt = N Lt = 2D
2.	Raghunath	45	"	Rt = .32 Lt = .38	Rt = 3D Lt = 2D	Rt = .37 Lt = .30	Rt = 3D Lt = 2D
3.	Ram Charan	35	"	Rt = .18 Lt = .17	Rt = 3D Lt = 3D	Rt = .20 Lt = .23	Rt = 2D Lt = 3D
4.	A. K. Das	40	"	Rt = .15 Lt = .22	Rt = 1D Lt = 2D	Rt = .13 Lt = .25	Rt = 1D Lt = 1D
5.	S. C. Mitra	45	"	Rt = .28 Lt = .36	Rt = 2D Lt = 3D	Rt = .25 Lt = .31	Rt = 1D Lt = 2D
6.	M. M. De	35	"	Rt = .38 Lt = .35	Rt = 1D Lt = 1D	Rt = .34 Lt = .38	Rt = 1D Lt = N
7.	N. M. Ghosh	60	"	Rt = .35 Lt = .21	Rt = 3D Lt = 1D	Rt = .39 Lt = .31	Rt = 2D Lt = 1D
8.	Bhagaban Bera	40	"	Rt = .26 Lt = .43	Rt = 1D Lt = 1D	Rt = .24 Lt = .41	Rt = 1D Lt = 1D
9.	Sk. Jalaluddin	55	"	Rt = .42 Lt = .26	Rt = 1D Lt = 1D	Rt = .35 Lt = .26	Rt = 1D Lt = 1D
10.	Sampat Rao	35	Comp. Fr. R. Leg	Rt = .21 Lt = .21	Rt = 1D Lt = 1D	Rt = .15 Lt = .20	Rt = 1D Lt = 1D
11.	T. Chakravarty	30	Fr. Patella Right	Rt = .17 Lt = .17	Rt = 1D Lt = 1D	Rt = .19 Lt = .19	Rt = 2D Lt = 3D
12.	Bandeo	35	Comp. Fr. R. Leg	Rt = .24 Lt = .16	Rt = 2D Lt = 2D	Rt = .32 Lt = .23	Rt = 1D Lt = 1D
13.	K. K. Charian	39	Hydrocoele	Rt = .27 Lt = .20	Rt = 1D Lt = 1D	Rt = .36 Lt = .23	Rt = 1D Lt = 1D
14.	Shamlal	16	Comp. Fr. L. Leg	Rt = .42 Lt = .20	Rt = 1D Lt = 1D	Rt = .36 Lt = .23	Rt = 1D Lt = 1D
15.	Ram Chandra	21	Hydrocoele	Rt = .42 Lt = .20	Rt = 1D Lt = 1D	Rt = .36 Lt = .23	Rt = 1D Lt = 1D

investigated. The foot prints of a large number of people while under these conditions were obtained and the average degree of weakness or otherwise as determined from these prints were compared with the average of apparently normal barefooted persons. Such conditions were:—(1) Patients while under the influence of spinal anaesthesia. (2) Patients suffering from complete paralysis of both inferior extremities due to any disease or to a lesion of the spinal cord. (3) Patients suffering from extensive inflammatory conditions around leg and foot. (4) Patients suffering from acute toxæmic conditions. (5) Female patients in late stages of labour or just after child-birth. (6) Foot prints obtained from recently amputated legs.

### Spinal Anaesthesia (Table III)

The foot prints of 15 patients before and about 10 minutes after the administration of spinal anaesthesia were obtained. (Fig. 11). : May & Baker's preparation—Dura-caine—hypobaric solution (S. G. 1002) was used in these cases.

About 3 c.c. was injected intrathecally. The patients were operated on for various conditions such as strangulated hernia, amputation of leg, compound fracture, rectal lesions, hydrocele etc. If the theory that the arch of the foot is maintained or at least partially supported by the postural tone of the muscles be true, spinal anaesthesia, since it abolishes this reflex tone by affecting the nerve roots, should have caused total or partial falling of this arch. That it did not do so is abundantly clear from the series of prints. It cannot be said that the rigidity of the arch was the result of restrictions of foot wear as most of these patients were from the labouring classes and very occasionally or rarely were accustomed to wear shoes. Comparison of the prints before and after anaesthesia revealed the following:—

	Before Anaesthesia	After Anaesthesia
Average arch fraction	.31	.26
1st degree of weakness	50%	50%
2nd degree of weakness	22%	18%
3rd degree of weakness	18%	15%
4th degree of weakness	Nil	
Normal feet		

TABLE IV

No.	Name	Age	Occupation	Lesion	Arch Fraction	Degree of Weakness
1.	Tuar	...	25	Labourer	Cerebral thrombosis c Hemiplegia.	Rt=.35 Lt=.30 Rt=Normal Lt=1D
2.	Argusha	...	25	Labourer	Spinal injury paraplegia.	Rt=.32 Lt=.45 Rt=2D Lt=3D
3.	Abdul Hamid	...	35	Labourer	Transverse myelitis paraplegia.	Rt=.30 Lt=.42 Rt=Normal Lt=1D
4.	Kasi Ram	...	26	Labourer	Spinal injury paraplegia.	Rt=.43 Lt=.46 Rt=1D Lt=2D
5.	Jamin	...	40	Sweeper	Spinal injury paraplegia.	Rt=.25 Lt=.30 Rt=2D Lt=1D
6.	Ramani	...	35	Coolie	Spinal injury paraplegia.	Rt=.30 Lt=.44 Rt=Normal Lt=1D
7.	S. Mondal	...	26	Labourer	Spinal injury paraplegia.	Rt=.25 Lt=.30 Rt=2D Lt=1D
8.	Sadhu	...	40	Labourer	Spinal injury paraplegia.	Rt=.38 Lt=.36 Rt=2D Lt=2D
9.	D. L Ram	...	45	Coolie	Spinal injury paraplegia.	Rt=.43 Lt=.35 Rt=2D Lt=1D
10.	B. Ali	...	40	Labourer	Spinal injury paraplegia.	Rt=.24 Lt=.22 Rt=Normal Lt=2D
11.	M. Bera	...	45	Coolie	Cervical paraplegia.	Rt=.20 Lt=.19 Rt=1D Lt=1D
12.	Meghnad	...	35	Cultivator	Cervical paraplegia.	Rt=.20 Lt=.19 Rt=1D Lt=2D
3.	Jagaya	...	35	Cultivator	Cervical paraplegia.	Rt=.35 Lt=.24 Rt=Normal Lt=1D
14.	N. Ghosh	...	30	Clerk	Compression fracture spine paraplegia.	Rt=.45 Lt=.44 Rt=3D Lt=3D
15.	Thakur	...	32	Cook	Transverse myelitis paraplegia.	Rt=.34 Lt=.42 Rt=Normal Lt=1D
16.	S. N. Banerjee	...	45	Lab. Asst.	Compression fracture spine paraplegia.	Rt=.32 Lt=.24 Rt=2D Lt=2D
17.	A. Kader	...	22	Coolie	Compression fracture spine paraplegia.	Rt=.35 Lt=.35 Rt=2D Lt=4D
18.	S. N. Chakravarti	...	19	Student	Compression fracture spine paraplegia.	Rt=.38 Lt=.38 Rt=2D Lt=2D
19.	Priyalal	...	25	Coolie	Spinal injury with paraplegia.	Rt=.40 Lt=.24 Rt=3D Lt=1D
20.	B. Kahaman	...	26	Labourer	Compression fracture spine with paraplegia.	Rt=.34 Lt=.30 Rt=2D Lt=2D





Fig. 12.  
Foot-prints of patients with paralysed lower extremities.

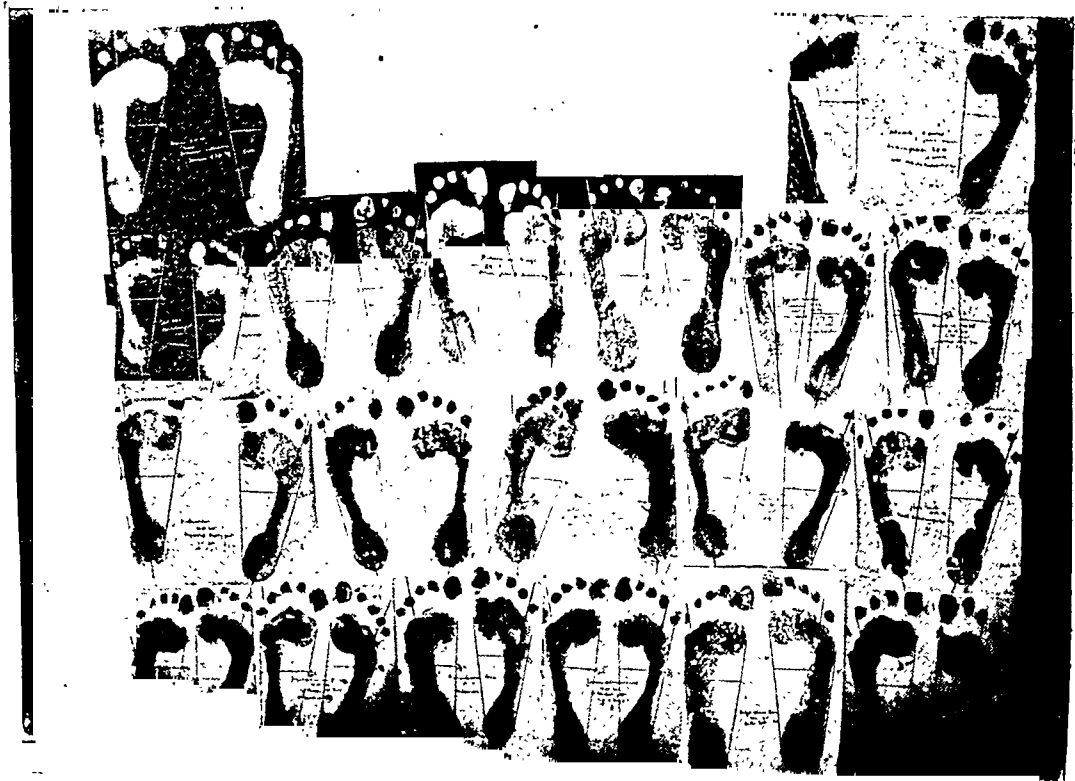


Fig. 13.  
Foot-prints of patients with acute inflammatory les

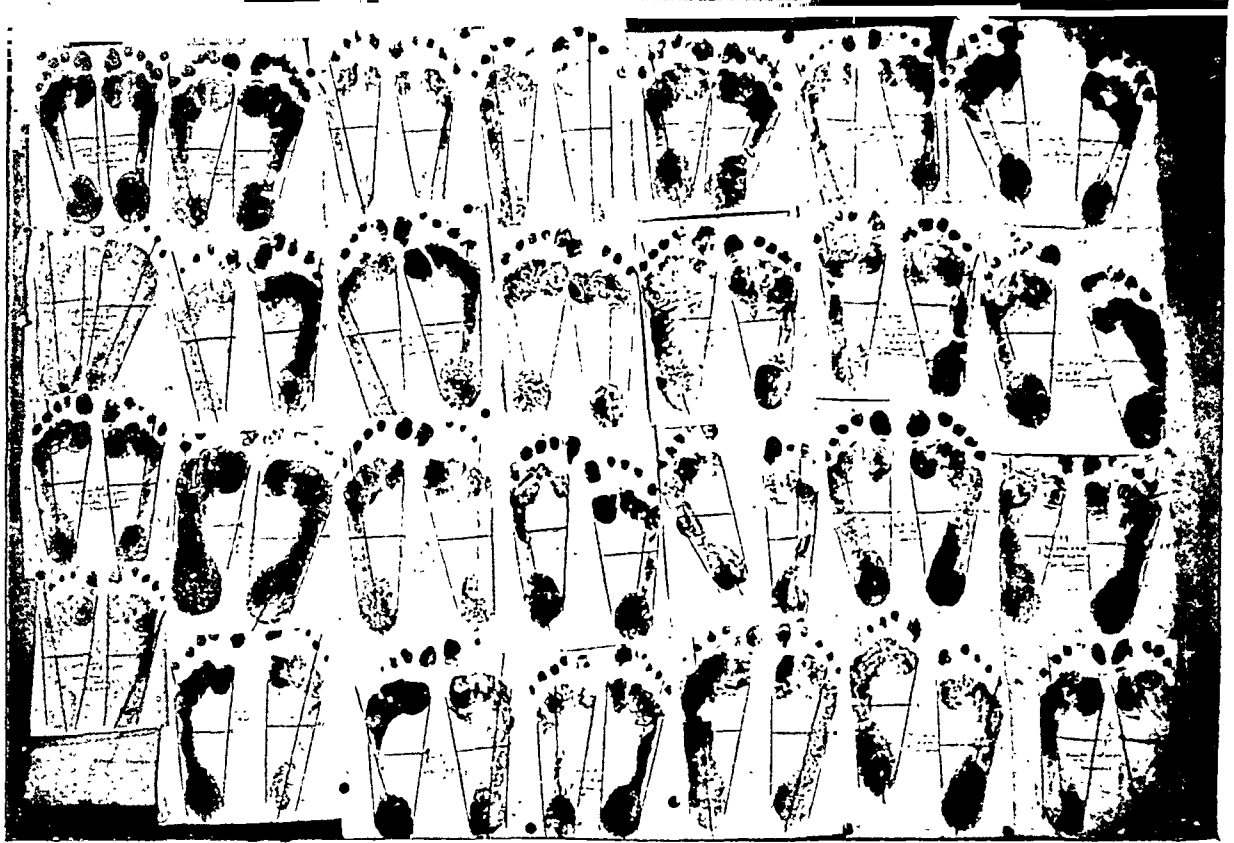


Fig. 14.

Foot-prints of patients with acute toxaemic conditions.

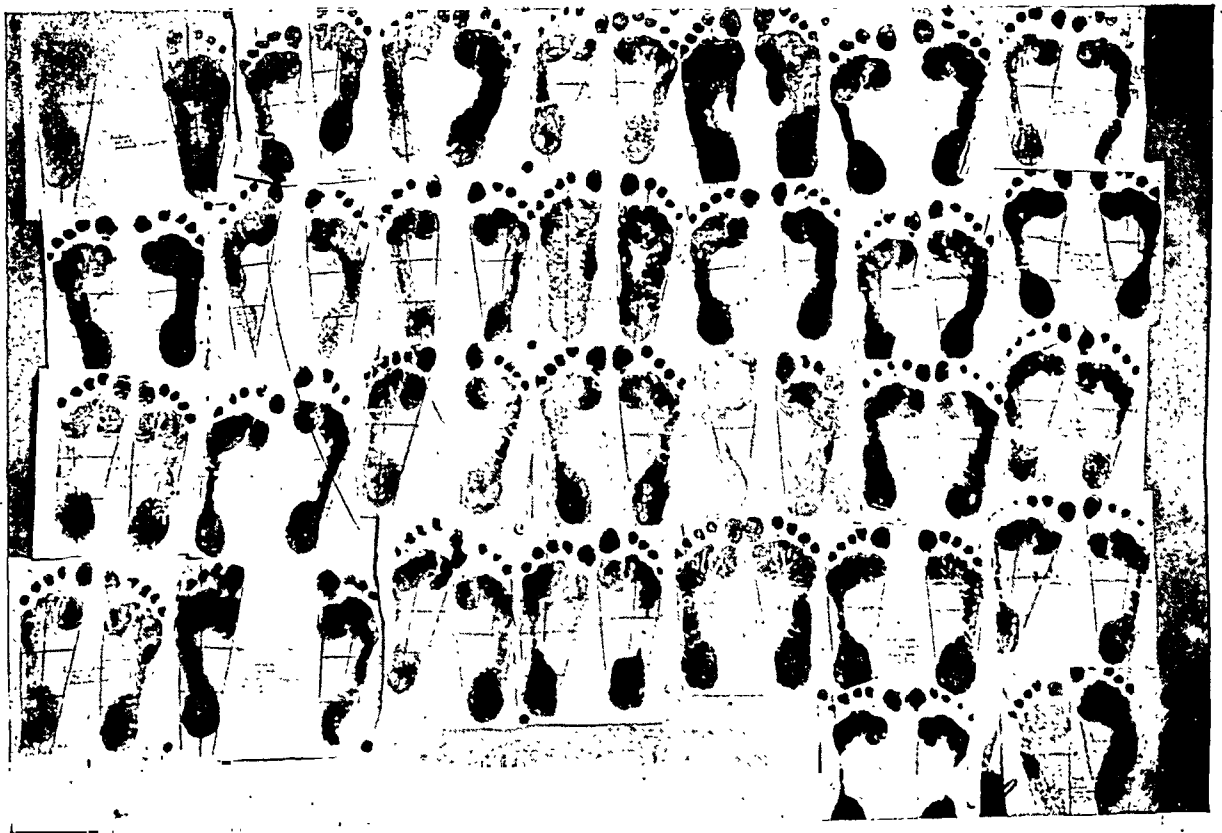


Fig. 15.

Foot-prints of pregnant women before or soon after child birth.

TABLE V

No.	Name	Age	Occupation	Disease	Arch Fraction	Degree of weakness
1.	Gopal	11	Nil	Chr. Osteomyelitis. lt. tibia.	Rt=.23 Lt=.26	Rt=2D Lt=1D
2.	Jagabundhu	24	Shop Keeper	Pyarthrosis. rt. knee. oedema legs.	Rt=.40 Lt=.29	Rt=1D Lt=2D
3.	Bani Gopal	34	Shop, Keeper	Compound septic fr. left leg.	Rt=.30 Lt=.34	Rt=1D Lt=Normal
4.	S. Dam	35	Labourer	Extensive cellulitis dorsum of left foot.	Rt=.19 Lt=.43	Rt=Normal Lt=Normal
5.	Raja Mia	44	Rajmistry	Cellulitis left leg & foot.	Rt=.35 Lt=.29	Rt=1D Lt=1D
6.	Ramabatar	57	Bearer	Osteomyelitis rt. foot.	Rt=.39 Lt=.24	Rt=Normal Lt=1D
7.	Jamir	27	Coolie	Cellulitis left leg.	Rt=.29 Lt=.27	Rt=2D Lt=1D
8.	P. Mahato	30	Cart driver	Septic injury left knee & cellulitis.	Rt=.29 Lt=.27	Rt=2D Lt=1D
9.	S. L. Patra	40	Labourer	Cellulitis left leg.	Rt=.40 Lt=.54	Rt=1D Lt=1D
10.	Jasimuddin	30	Cultivator	Cellulitis foot leg & thigh rt.	Rt=.31 Lt=.32	Rt=1D Lt=1D
11.	Jiban Mandal	14	Coolie	Osteomyelitis rt. leg.	Rt=.31 Lt=.32	Rt=1D Lt=2D
12.	J. Narman	40	Electric Mistry	Old septic injury left leg with atrophy & contracture of muscles.	Rt=.33 Lt=.34	Rt=1D Lt=2D
13.	F. Mandal	40	Methar	Infected fr. rt. leg.	Rt=.29 Lt=.32	Rt=1D Lt=1D
14.	Sree Krishna	50	Coolie	Cellulitis left foot.	Rt=.30 Lt=.30	Rt=1D Lt=1D
15.	Sk. Panchu	30	Foreman ship	Infected fr. rt. leg.	Rt=.42 Lt=.26	Rt=Normal Lt=Normal
16.	Bahadur	23	Durwan	Osteomyelitis rt. hip with amyloid disease.	Rt=.37 Lt=.23	Rt=1D Lt=3D
17.	Navajiban	40	Coolie	Extensive cellulitis left leg.	Rt=.39 Lt=.40	Rt=1D Lt=1D
18.	B. N. Singh	24	Driver	Osteomyelitis rt. foot.	Rt=.29 Lt=.24	Rt=Normal Lt=1D
19.	Suleman	30	Coolie	Infected injury foot.	Rt=.27 Lt=.32	Rt=1D Lt=1D

TABLE VI

No.	Name	Age	Occupation	Disease	Arch Fraction	Degree of weakness
1.	S. Banerjee	...	17	Student	Enteric fever 16 days.	Rt=.36 Lt=.43 Rt=1D Lt=Normal
2.	Luxmi	...	12	Student	Enteric fever 40 days.	Rt=.37 Lt=.29 Rt=Normal Lt=Normal
3.	K. P. Sanyal	...	28	Clerk	Enteric fever 20 days.	Rt=.38 Lt=.37 Rt=1D Lt=2D
4.	Jagannath	...	16	Labourer	Enteric fever 16 days.	Rt=.21 Lt=.19 Rt=1D Lt=1D
5.	U. N. Das	...	26	Driver	Enteric fever 26 days.	Rt=.24 Lt=.11 Rt=Normal Lt=Normal
6.	Sankar	...	25	Cook	Enteric fever 20 days.	Rt=.38 Lt=.20 Rt=1D Lt=1D
7.	J. Ali	...	35	Labourer	Enteric fever 24 days.	Rt=.42 Lt=.41 Rt=Normal Lt=1D
8.	Bilasi	...	26	Nil	Pneumonia.	Rt=.25 Lt=.22 Rt=1D Lt=2D
9.	M. Omar	...	26	Bearer	Pneumonia.	Rt=.51 Lt=.38 Rt=1D Lt=1D
10.	B. Bagal	...	24	Cultivator	Pneumonia.	Rt=.44 Lt=.46 Rt=2D Lt=2D
11.	J. Das	...	40	Labourer	Pneumonia.	Rt=.44 Lt=.39 Rt=1D Lt=1D
12.	Pania	...	48	Nil	Pneumonia.	Rt=.26 Lt=.42 Rt=3D Lt=1D
13.	P. Paramanik	...	22	Barber	Pneumonia 10 days.	Rt=.35 Lt=.22 Rt=Normal Lt=Normal
14.	H. P. Sarkar	...	23	Cultivator	Fever 10 days.	Rt=.23 Lt=.26 Rt=1D Lt=1D
15.	G. Misir	...	43	Durwan	Fever 5 days.	Rt=.28 Lt=.32 Rt=3D Lt=2D
16.	P. Ghosh	...	26	Nil	Chr. malaria one year.	Rt=.28 Lt=.34 Rt=Normal Lt=1D
17.	Imam Sarif	...	60	Nil	Malaria with oedema legs extreme emaciation.	Rt=.35 Lt=.34 Rt=Normal Lt=1D
18.	J. Misry	...	35	Electric Mistry	Electric shock.	Rt=.44 Lt=.53 Rt=Normal Lt=Normal
19.	K. C. Ghosh	...	32	Clerk	Fever 1 month.	Rt=.22 Lt=.26 Rt=Normal Lt=Normal
20.	N. Bibi	...	28	Nil	Fever 1 month.	Rt=.46 Lt=.45 Rt=1D Lt=1D
21.	Sindhu B. Dasi	...	25	Nil	Nephritis with oedema legs.	Rt=.18 Lt=.24 Rt=1D Lt=Normal
22.	Ganesh	...	50	Nil	Ascites with oedema legs.	Rt=.39 Lt=.11 Rt=Normal Lt=Normal
23.	Janaki	...	26	Labourer	Congestive cardiac failure.	Rt=.41 Lt=.50 Rt=1D Lt=1D
24.	Makhan Lal	...	25	Labourer	Diabetes extreme emaciation.	Rt=.21 Lt=.26 Rt=1D Lt=2D
25.	Aminulla	...	22	Street begger	Septicaemia	Rt=.44 Lt=.26 Rt=1D Lt=1D
26.	J. Alam	...	20	Labourer	Haemothorax c septicaemia.	Rt=.26 Lt=.24 Rt=Normal Lt=1D
27.	S. Das	...	26	Bearer	Enteric 22 days.	Rt=.29 Lt=.24 Rt=1D Lt=1D
28.	N. Khan	...	40	Durwan	Amyloid disease with chr. osteo myelitis.	Rt=.22 Lt=.23 Rt=2D Lt=Normal

The differences therefore between the two sets of prints are not such as to suggest that the administration of spinal anaesthesia produces any lowering of the arch.

#### Paralysis of inferior extremities (Table IV)

The next series of 20 patients had complete sensory and motor paralysis of both inferior extremities. Most of these patients were cases of spinal injury with compression fracture of the vertebrae and involvement of the cord. Two were cases of transverse myelitis of syphilitic origin and one was a case of cerebral thrombosis with hemiplegia. Since the postural tone is a reflex mechanism depending primarily on the integrity of the rubrospinal tract, it would be expected that in these conditions there would be lessening or abolition of the tone and the consequent falling of the arch according to the postural theory. Such lowering of the arch is not evident in the foot prints of the 20 patients examined (Fig. 12). The arch was as prominent as in normal individuals and the rigidity and the integrity of the foot were quite normal. The average arch fraction was .32.

1st degree of weakness	..	30%
2nd degree of weakness	..	43%
3rd degree of weakness	..	10%
4th degree of weakness	..	Nil
Normal feet	..	15%

#### Acute inflammatory lesions of the leg and foot (Table V)

The 3rd series included 19 patients who were suffering from acute inflammatory lesions affecting the leg and foot. These included cellulitis foot, osteomyelitis foot, compound infected fractures around leg and foot etc. Under these conditions it is supposed, according to the postural theory, that there would be inhibition of the postural tone of the muscles which are included in the inflammatory area and consequent falling of the arch. That there is no such reduction in the height of the arch is plainly evident from the foot prints obtained in

such cases (Fig. 13). The average arch fraction was .34.

1st degree of weakness	..	47%
2nd degree of weakness	..	22%
3rd degree of weakness	..	6%
4th degree of weakness	..	3%
Normal feet	..	15%

The inflammatory disturbances were not deep or severe enough to affect the ligamentous structures of the feet to a great degree. When these capsular ligaments are really affected, as they are, in extensive gonorrhoeal infections of the foot, there is rapid falling of the arch proving the importance of the ligaments in the maintenance of the arch.

#### Acute toxæmic conditions (Table VI)

The fourth series included 28 patients who have been suffering from acute toxæmic conditions such as enteric fever, pneumonia and other long continued illnesses. It is held that under these conditions there is a reduction of the general tonus of the muscles of the body and so a lowering of the arch is to be expected. Evidence of decrease of muscular tonus in such toxæmic states is furnished by (a) general flaccidity of the muscles throughout the body (b) Loss of the normal spinal curvatures. (c) Difficulty of and weakness in raising the head, sitting up, standing up etc. in the convalescent stage. It will be seen that the arches in such patients are well developed (Fig. 14). Included in the series is a print of a congenital diabetic case (No. 3—Table 6—No. 15—Fig. 14). This patient has been in and out of hospital for a number of years and is now extremely emaciated and run down. His muscles are all flabby and apparently have little postural tone. His arches however are well developed and conform to the type of bare footed individuals (No. 15 Fig. 14). This case proves also that the failure or lowering of the arch is not associated with wasting or atrophy of the muscles and therefore cannot be said to depend upon its tone. In this series the average arch fraction was .31.

TABLE VII

No.	Name	Age	Stage of Pregnancy	Arch Fraction	Degree of Weakness
1.	Subasini Dasi	25	Abortion 5 months	Rt = .30 Lt = .23	Rt = 2D Lt = 2D
2.	Charu Halder	42	2 Days after labour	Rt = .48 Lt = .44	Rt = 3D Lt = 2D
3.	Rashmoni	22	1 Day "	Rt = .31 Lt = .13	Rt = 2D Lt = N
4.	Rama Dasi	26	3 Days "	Rt = .28 Lt = .28	Rt = 1D Lt = 1D
5.	Nirmala Roy	24	1 Day "	Rt = .40 Lt = .38	Rt = 3D Lt = 2D
6.	Puspa	32	8 Hours "	Rt = .38 Lt = .39	Rt = 1D Lt = N
7.	Hari Dassi	22	2 Days "	Rt = .29 Lt = .31	Rt = 1D Lt = 2D
8.	Niharbala	21	1 Day "	Rt = .97 Lt = .98	Rt = 4D Lt = 4D
9.	Mrs. Milston	23	Pregnent 8 months	Rt = .89 Lt = .80	Rt = 3D Lt = 3D
10.	Gola Bibi	20	1 Day after labour	Rt = .26 Lt = .16	Rt = 3D Lt = 2D
11.	Mrs. Bhattacharya	21	4 Days "	Rt = .21 Lt = .24	Rt = 2D Lt = 1D
12.	Mrs. Biswas	23	6 Hours "	Rt = .19 Lt = .16	Rt = 2D Lt = 3D
13.	Mrs. Bhattacharya	25	1 Day "	Rt = .10 Lt = .20	Rt = 3D Lt = 2D
14.	Basirani	25	Anaemia with pregnancy full term	Rt = .31 Lt = .34	Rt = 2D Lt = N
15.	Kunti Devi	23	Pregnancy 9 months	Rt = .44 Lt = .38	Rt = N Lt = N
16.	Sakina Bibi	23	1 Day after labour	Rt = .60 Lt = .30	Rt = 2D Lt = 1D
17.	Bina Dasi	18	1 Day "	Rt = .41 Lt = .26	Rt = 1D Lt = 3D
18.	Dhalia	26	2 Days "	Rt = .29 Lt = .16	Rt = N Lt = 1D
19.	Mrs. S. Das	18	Full term pregnancy	Rt = .18 Lt = .23	Rt = 2D Lt = 1D
20.	Luxmi	26	"	Rt = .12 Lt = .10	Rt = N Lt = N
21.	Kanchi	25	2 Days after labour	Rt = .51 Lt = .51	Rt = 1D Lt = 1D
22.	Golapi	20	1 Day "	Rt = .14 Lt = .10	Rt = 2D Lt = 2D
23.	Mahamaya Dutt	25	1 Day "	Rt = .23 Lt = .17	Rt = 1D Lt = 1D
24.	Shanta Maya	22	2 Days "	Rt = .38 Lt = .25	Rt = 1D Lt = 2D
25.	Prativa	30	11 Hours "	Rt = .88 Lt = .52	Rt = 4D Lt = 3D
26.	Sarojini	20	1 Day "	Rt = .43 Lt = .44	Rt = 2D Lt = 2D
27.	Bhaktilata	30	4 Days "	Rt = .27 Lt = .11	Rt = N Lt = 1D
28.	Dipali	30	2 Days "	Rt = .26 Lt = .26	Rt = 1D Lt = 1D
29.	Charu Dasi	32	1 Day "	Rt = .31 Lt = .28	Rt = N Lt = N
30.	Hamidan Bibi	26	2 Days "	Rt = .44 Lt = .36	Rt = 2D Lt = 2D

TABLE VIII

No.	Name	Age	Cause of Amputation	Arch Fraction	Degree of Weakness
1.	Mahatab	22	Extensive crushed injury left leg.	.45	3D
2.	Dukhi	60	Compound fracture leg with gas gangrene.	.22	N
3.	Nagina	31	Compound fracture both bones of the leg with extensive infection.	.24	1D
4.	Osman	48	Extensive lacerated injury leg with compound fracture.	.32	1D
5.	Pirmalli	60	Extensive crushed injury leg.	.18	1D
6.	Chammal	26	Chronic extensive osteomyelitis leg.	.42	N
7.	Umapada	42	"	.36	N
8.	Sakri	45	Compound fracture leg with extensive infection.	.22	1D
9.	Bistu	35	Extensive crushed injury leg.	.18	N
10.	Rambaran	24	"	.14	N
11.	Sakur	34	Gas gangrene following infected lacerated injury leg.	.36	1D
12.	Dukhan	26	Compound dislocation knee joint with infection.	.31	2D
13.	Ghuram	16	Crushed injury leg.	.12	N
14.	Mangal	29	"	.38	1D
15.	Taher Ali	16	Gasgangrene leg following lacerated injury.	.20	1D
16.	Md. Yusuf	42	Extensive lacerated injury leg.	.12	1D
17.	M. M. Ali	30	Extensive crushed injury leg.	.21	1D
18.	Jaytan	21	Infected crushed injury leg.	.29	2D
19.	A. Khalek	36	"	.34	2D
20.	Abdur Rahaman	36	Compound fracture both bones of leg with osteomyelitis.	.24	2D

1st degree of weakness	..	47%
2nd degree of weakness	..	15%
3rd degree of weakness	..	4%
4th degree of weakness	..	Nil
Normal feet	..	33%

#### Pregnancy (pre- or post-partum stage) (Table VII)

Foot prints of 30 patients in late stage of labour or immediately after child birth were obtained (Fig. 15). Two factors which can influence the arch of the foot operate during the stage of pregnancy. One is the general reduction of tone of all the muscles of the body as evidenced by the flaccidity of the muscles and the other is the relaxation of the ligaments, mainly in the pelvic joints but also to a lesser extent throughout the other joints of the body.

It would be expected therefore that in pregnancy and especially immediately after labour the arch of the foot should show some evidences of lowering—at least in some of the cases and in fact repeated pregnancy is mentioned as one of the causes of acquired flatness of the foot (Gellhorn—1917).

The foot prints obtained in my cases prove the veracity of this statement. Of the 30 patients examined, there are some, whose foot prints correspond to those of the booted people viz. there is abduction of the forepart of the foot with increase of the arch fraction. Moreover in 3 cases the arch is nearly flat and the arch fraction nearly approximate unity viz. in cases of Mrs. Milston, Prativa (Rt. foot) and Niharbala. In the remaining patients the foot prints still correspond to those of the bare footed type with well marked arch and low arch fraction. Average arch fraction .45.

1st degree of weakness	..	26%
2nd degree of weakness	..	34%
3rd degree of weakness	..	26%
4th degree of weakness	..	5%
Normal feet	..	12%

#### Recently amputated legs (Table VIII)

19 foot prints were obtained from recently amputated legs (Fig. 16). The amputa-

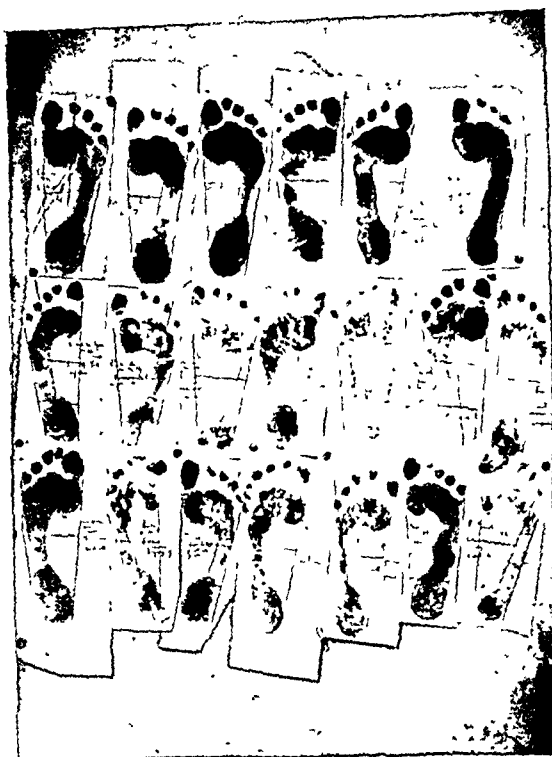


Fig. 16.  
Foot-prints of recently amputated legs.

tion was done for various reasons such as crushed injuries of the leg, gas infection etc. The prints were taken by placing the foot on a paper fixed on a wooden frame and applying moderate amount of force (72 lbs.) on top of it. If the arch was solely maintained by the postural tone of muscles, there would have been some lowering of the arch under these conditions. Such lowering did not occur, the arches were as prominent after as before the amputation and the placings of weight on the feet made little difference to the height of the arch.

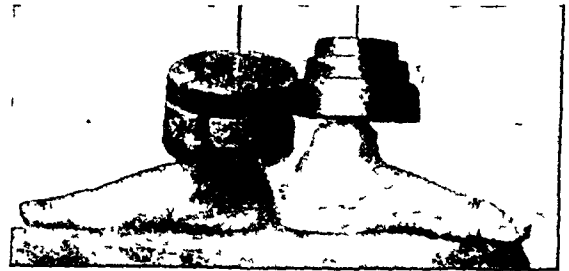
1st degree of weakness	..	42%
2nd degree of weakness	..	10%
3rd degree of weakness	..	14%
4th degree of weakness	..	Nil
Normal feet	..	32%

The average arch fraction in this series was .26.

### The influence of ligamentus support on the arch of the foot

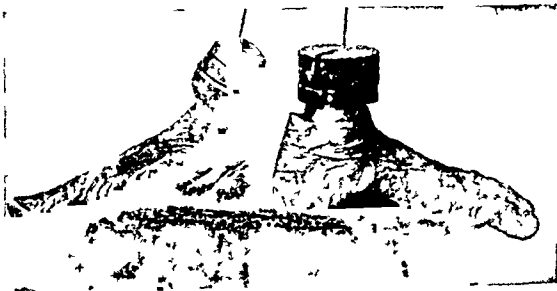
To determine the influence of the ligamentus structure on the arch of the foot I made a series of investigation. Immediately after amputation the amputated legs were injected with a fluid consisting of equal parts of glycerine, alcohol and carbolic acid and afterwards kept immersed in the same solution. The skin over the ankle and foot was undisturbed throughout all the experiments. The joints and tendon sheaths were thoroughly injected with a lubricant—oil of sesame was found to be satisfactory (Jones 1941). With such care, the experimental foot remained soft and pliable throughout the experiments. I made a small vertical incision on the medial side just below the head of the astragalus and sustentaculum in one of each pair of feet and with a long Paget's knife cut all the ligaments structures especially the planter calcaneo-navicular ligament, the long and short planter ligaments and the origin of the plantar ligaments and the planter fascia from the medial tuberosity of the os calcis. This foot was then mounted together with its fellow

(whose ligaments are intact) on a block of wood and about 36 lbs. of weight was placed on each (Fig. 17). Comparison of these feet whose ligaments have been cut with the normal feet (whose ligaments are intact) show how the former bereft of the ligamentus influence reacted to the load of weight. There is more or less lowering of the arch in every case. This can only be due to the absence of the ligamentous and the facial support as the muscles in both cases were already devoid of all postural tone. The lowest figure shows the height of the arch in a foot whose ligaments have been cut and the depression that occurs after putting 72 lbs. of weight on top of it.



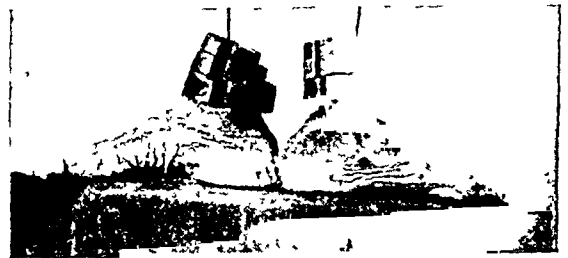
Ligaments cut

Ligaments intact



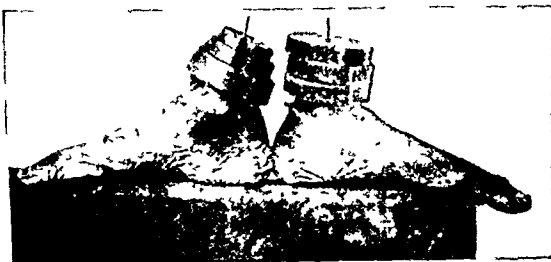
Ligaments cut

Ligaments intact



Ligaments intact

Ligaments cut



Ligaments intact

Ligaments cut

Ligaments cut  
with weight (72 lbs)Ligaments cut  
without weight

Fig. 17.





Fig. 18.

Foot-prints of infants from birth to 1 year.

### Stages in the development of the arch of the foot after birth

To examine the stages in the development of the longitudinal arch of the foot from infancy to adolescence, I obtained a series of foot prints from new born babies up to the age of 10 years. About 25 prints were obtained of each year and their relative comparison reveals many interesting features. The deductions made by the examination of these prints, though not conclusive by themselves, when co-related with findings from other examinations are corroborative and, therefore, are of importance.

#### BIRTH TO 1 YEAR

(28 pairs of feet—fig. 18)

12 pairs of prints were obtained of babies within 24 hours of their birth. Of these 3



Fig. 19.

Average picture of a foot-print from birth to 1 year.



Fig. 20.

Foot-prints of infants from 1 to 2 years.

are included in the figure. It will be seen that the foot of the new born is peculiar in many respects. The foot as a whole is more triangular than in the adult tending to be equilateral. The heel is small and narrow. The toes are divergent, spreading out in radiating lines from the heel. There is no arch—the arch fraction is 1. Another feature is the presence of the flexion creases like those present in the hand. The same characteristics i.e., the triangular feet with the narrow heel, absence of arch and the presence of flexion creases dividing prominent pads of fat are seen in the prints of adult monkeys' feet. The triangular character of the feet with the narrow pointed heel persists upto about the age of 5 months when the heels begin to broaden somewhat. The average arch fraction of this group of cases from birth to 1 year is .88. An average picture of the foot print of a new born is shown in Fig. 19.



Fig. 21.

Average picture of a foot-print from 1 to 2 years.



Fig. 22.

Foot-prints of children of 2 to 3 years.

## 1 TO 2 YEARS

Above one year and upto 2 years, 29 foot prints were obtained. The general characteristics of the foot are the same as in the new born (Fig. 20) though the heel is less narrow and pointed. A new feature is the beginning of the appearance of the arch as evidenced by the slight concavity on the medial borders of the feet. This was not present in all the prints and in seven cases the arch was completely flat. The average arch fraction was .80. An average picture of the foot print at this stage would be as shown in the Fig. 21.

## 2 TO 3 YEARS

Above 2 and upto 3 years of age the appearance of the arch is more prominent. 30 pairs of feet were examined (Fig. 22).



Fig. 23.

Average picture of foot-prints of children of 2 to 3 years.



Fig. 24.

Foot-prints of children of 3 to 4 years.

The rudimentary arch was present in 56 of the 60 prints obtained. In four cases the arch was still nearly flat. The average arch fraction is .66. It will be seen that the concavity on the medial border is still not sharp and in those cases in which it is well developed, it conforms to the type seen in the booted individuals. In only one case it corresponds to the type seen in bare footed people. This shows that the arch is still very low and not well developed. Average prints at this stage would look like that shown in Fig. 23.

### 3 TO 4 YEARS

Above 3 years and upto 4 years (24 pairs of feet)—the arch is gradually taking the shape of adult proportions though it has not yet attained the average shape of the bare

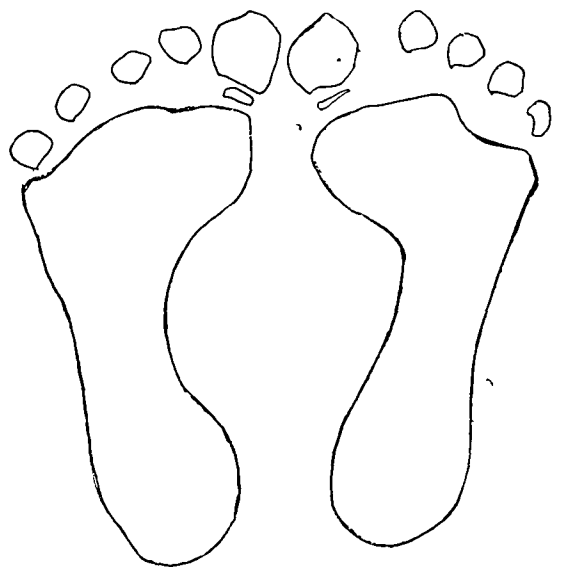


Fig. 25.

Average picture of foot-prints of children of 3 to 4 years.



Fig. 26.

Foot-prints of children 4 to 5 years.

footed people except in 4 prints (Fig. 24). In another 4 prints the medial border is full and the arch flat. An average print of this stage is shown in Fig. 25. The average arch fraction of this group of cases is .61.

#### 4 TO 5 YEARS

Above 4 years and upto the 5th year of age (26 pairs of feet) the shape of the foot prints in some of the cases have assumed the adult bare footed type (Fig. 26) but in some it still shows different degrees of flatness. The average arch fraction is .51. An average type of foot print of this age may be seen in Fig. 27.

#### 5 TO 6 YEARS

Above the age of 5 years the arches have reached adult proportions and in most of the cases the print shows the type seen in bare footed people though in a few cases the arch is still low (Fig. 28). The average

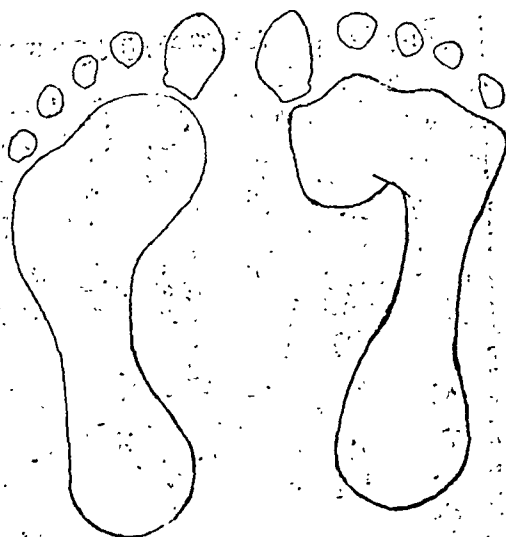


Fig. 27.

Average picture of foot-prints of children of 4 to 5 years.

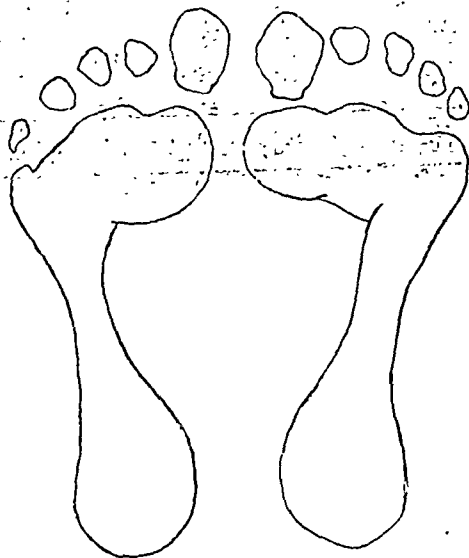


Fig. 29-a.

Average picture of foot-prints above 6 years of age.

arch fraction of the foot prints between the ages 5 to 6 is .42.

#### 6 TO 10 YEARS

Above the ages of 6 years and upto the age of 10 years the prints are all included together and show well developed arch in every case (Fig. 29). The average arch fraction of this group is .39.

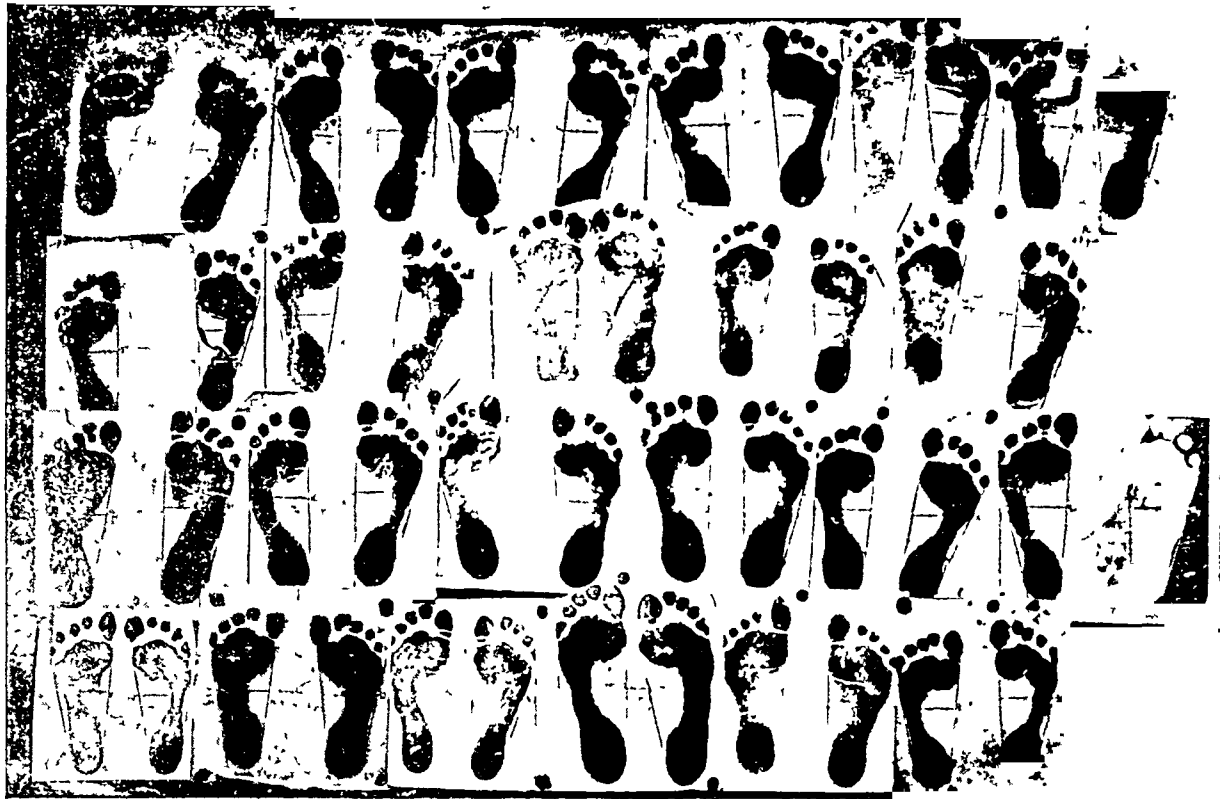


Fig. 28.

Foot-prints of children 5 to 6 years.

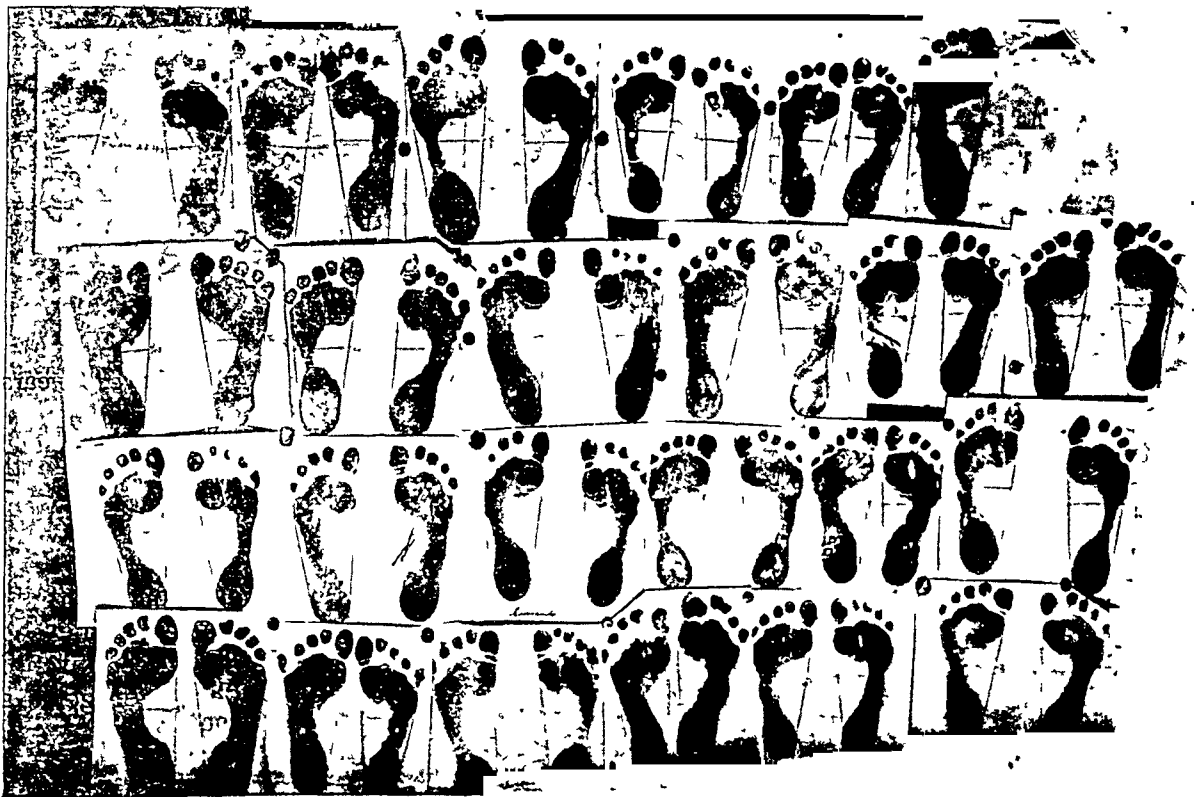


Fig. 29.

Foot-prints of children 6 10 years.

It will be conceded, therefore that the well formed arch of the foot that we see in adult bare footed people is of gradual development. As seen in the series of prints, the medial border becomes increasingly more concave from the age of 6 months and assumes adult shape and proportion after the age of 5 years.

If a graph is drawn in which the abscissa show the age of the child and the ordinate the average arch fraction each year it will

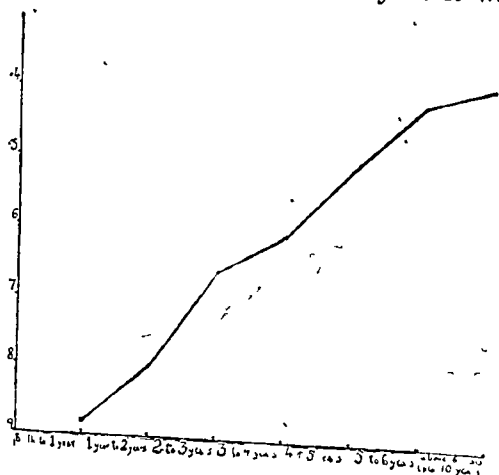


Fig. 30.

Graph showing arch fraction with the increasing age of children.

form a line (as shown in the Fig. 30), ascending upwards, showing that the arch fraction gradually diminishes and therefore the height of the longitudinal arch gradually increases from birth upto the age of 5 years.

Age	Average Arch Fraction
Birth to 1 year	.. .88
1 to 2 years	.. .80
2 to 3 years	.. .66
3 to 4 years	.. .61
4 to 5 years	.. .51
5 to 6 years	.. .42
above 6 years & upto 10 years	.. .39

A similar opinion is expressed by Bloxöm who studied the feet of a large number of infants and children. He writes "The rate

of development of the feet and its longitudinal arch varies considerably but as a rule progresses most rapidly in the period from 1 to 4 years. There is no essential difference between boys and girls in the rate of development of the arches. There are a certain number of children whose feet continue in a non-developing stage, and corrective measures applied over years do no good. Up to the time of writing, no foot in the developing group that was subsequently re-examined has returned to the non-developing state."

From this finding of slow and gradual development of the arch of the foot as the child increases in age, certain conclusions can be drawn. It is clear that the development of the arch cannot be due to the appearance of postural tone in the anti-gravity muscles of the leg as explained by the adherents of the postural theory. If that was so, the arch would have been present in its fully developed stage by the age of 18 months when the child had assumed erect position and learnt to walk.

All other characteristics of the human anatomy such as holding up of the head (3 months), sitting upright (6 months), standing erect (1 year) which appear in this period of transition and which are said to be due to the assumption of this postural tone of the anti-gravity muscles are complete within this 18 months period and it is difficult to understand why the arch of the foot, if it was due to the same cause, should appear so late and so slowly and gradually.

Instead, this gradual appearance of the arch of the foot and its assumption of adult proportions after the child has attained a number of years suggests, that there is a slow process at work. As will be shown later on the proportion of soft tissues, fasciae, fat and muscles is comparatively greater in the foot of the new born babies than in the adult feet (Fig. 31). This preponderance of soft tissues relative to the skeletal element persists though in diminishing degree—until about the age of

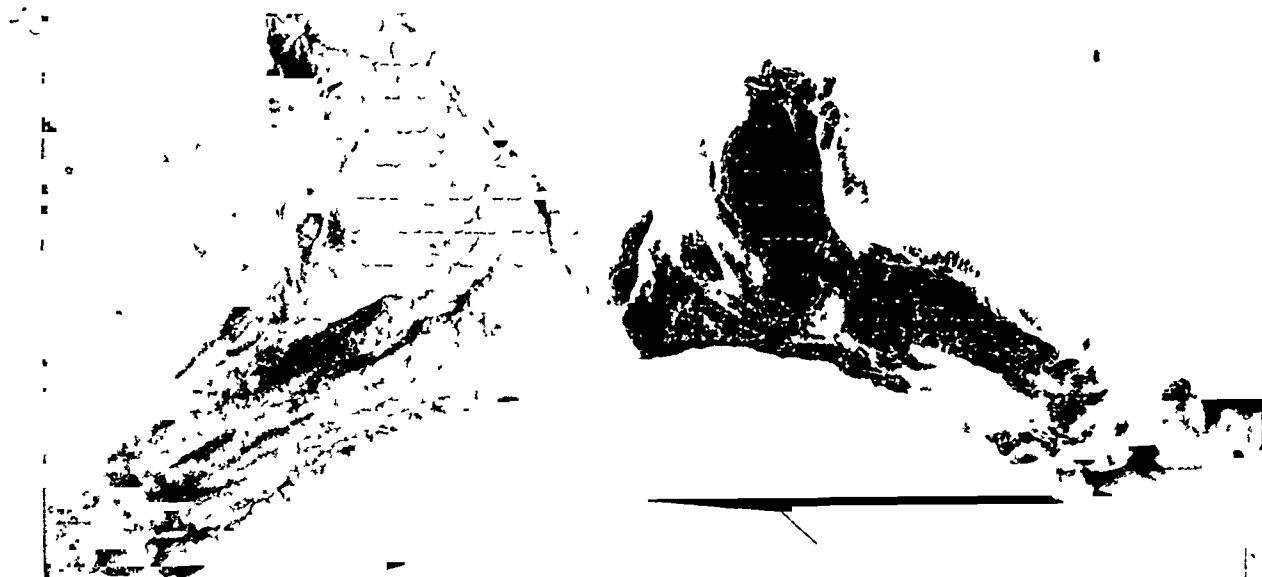


Fig. 31

Dissection of feet of a new born baby to show how the arch is hidden by soft tissue element.

5 years. Is it not rational therefore to conclude that the appearance of the arch in the feet of human infants is due to this gradually increasing disproportion of skeletal and soft tissues as they grow up and that the arch assumes its adult proportions when this ratio is stabilized. The causes of diminution in the proportion of soft tissues in the feet are (a) the gradual atrophy of the fatty elements—a phenomenon which also takes place everywhere else in the body as the child grows up—as evidenced by the loss of roundness in the shoulders, hips, face etc., & (b) the increasing stiffness and inelasticity of the ligaments which fixes the arch and prevents the depression.

After examination of the feet of about 200 children of different ages, it was easy to see that the feet of the infants as they grew up became increasingly stiff and rigid. Within the uterus the feet are so pliable that they assume a completely inverted position (Keith 1933). After birth the feet are very soft and resilient and the range of movement among the different joints is

considerably greater than in the adult feet. The inverted position is gradually lost and according to Sweetapple (1932) the majority of the feet in infants assume a calcaneo-valgus position.

Persistence of the uterine inverted position and non-assumption of the everted attitude is according to Keith (1933) and Whitman the cause of the commonest foot deformity of infants—talipes equinovarus.

The resiliency, suppleness and the range of movement of the infant's foot gradually diminishes as the child increases in years and it was found that the same rigidity and fixity of the adult foot that was previously described even in bare footed persons is assumed by the child's foot at or after the age of five years. It is therefore rational to say that the same factors which cause the rigidity also reveal the arch in the child's foot.

The views of certain other writers as regards the development of the arch in a baby's foot may here be quoted. Elmslie



(Practitioner—July 1930) says that there is no arch, when a child begins to walk—with the weight chiefly on the inner side and the feet apart. When walking improves, the feet are brought closer together and weight is gradually thrown on the outer side. This usually takes a few months, during which the arch develops. Lake (1935) says that the apparent depression of the arch of the foot in a baby is more due to the contour of the soft parts than to the rigid skeletal basis. Normally there is a well developed pad of fat under the instep, which obscures the outline of the cartilages, but in wasted infants, when the pad has disappeared, a well marked arch can be seen and the dissection of the skeletal basis confirms this observation. Ontogenetically and perhaps phylogenetically the development of an arch is foreshadowed long before any question of postural tonus comes into play.

Bankart—The child's foot is flat, because postural tone has not developed in the anti-gravity muscles. As the child gradually learns to walk, postural tone is developed and the tendency to passive abduction and eversion is from that time onwards, resisted by tonic muscular activity.

Lewin (1931)—The foot print of the new born infant is inadequate and misleading in that it usually looks flat because the bony arch is obliterated by a pad of fat. In fact, the feet of the new born infant reveals in cross section a definite bony arch but in a position of pronation to which the term pes valgus has been applied.

Henke (1859), Hueter and Lorenz (1883) considered that the foot is flat in all new born infants, while Kirrmission (1898) considered that the arch is formed after birth under the influence of the contraction of muscles which become active at the time of walking.

Bane (1892) and Hohm (1932) through longitudinal section of the foot proved that a plantar arch exists at the time of birth and is buried in the mass of fatty tissue which is very well developed in this region in the newly born.

Higgs (1937) says that the apparent flatness of the foot in a baby is due to the calcaneo-valgus position (while *in utero*) and overstretching of the invertor and adductor group of muscles. If this is not corrected in time, congenital flat foot results.

Keith (1933)—At birth the child is flat footed when the weight of the body rests on it—the head of the astragalus touches the ground. When the muscles are removed by dissection, the foot of the newly born child shows a well developed arch. The arch becomes stable as the child learns to walk.

#### Embryological investigation of the development of the arch of the foot

During the course of my embryological investigation, I examined the feet of about 200 foetuses. Some of them were amongst the embryological collection of the museum of the department of anatomy of the Calcutta Medical College, while others were specially obtained from the Eden and the Sambhu Nath Pandit Hospitals. The foetuses were of different ages—the smallest was 8.5 mm C.R. length, and the largest were full time foetuses.

A preliminary naked eye examination of the feet of the very small foetuses and their comparison with the hands revealed interesting features (Fig. 32). It will be seen that at the 8.5 mm C.R. length stage (approximately 5th week), the limb buds have just appeared and are directed at right angles to the axis of the body. There is no differentiation of the limbs into different segments. The hand and foot are represented by circular pads at the ends of the extremities and the digits have not appeared.

At the 16 mm. C.R. length stage (approximately 6 weeks), the extremities both upper and lower show the beginning of the differentiation into three segments (thigh, leg and foot—the arm, fore-arm and hand). The digits have appeared both in the hand as well as in the foot. It will be seen that both in the hand and in the foot, the digits

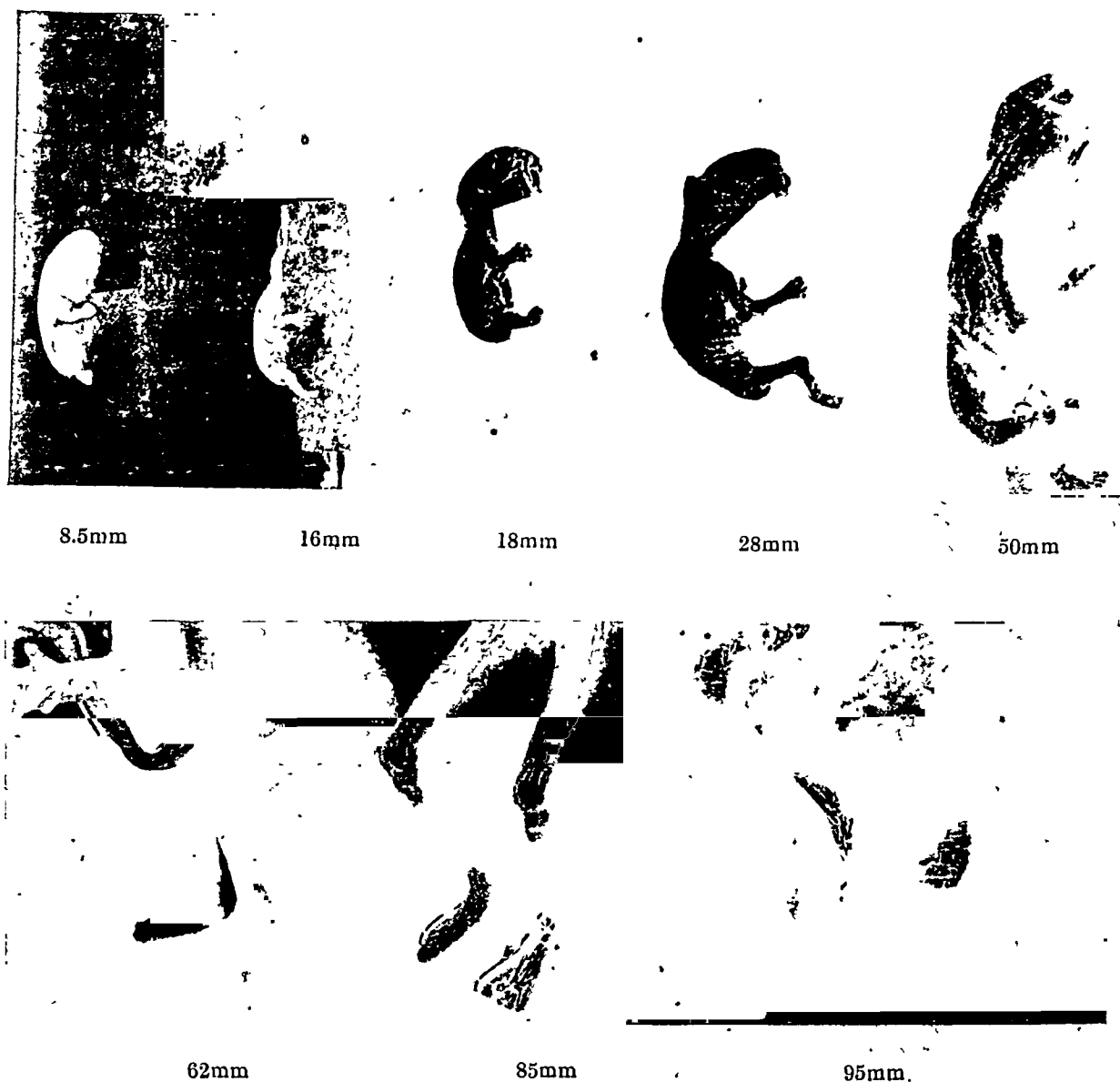


Fig. 32.

Stages of development of the foot and longitudinal arch in the small fetuses

are radially divergent and that both the hallux and the pollex are abducted away from the middle line. There is no heel and the foot is in the same axis as the leg. In fact both the hand and the feet look extremely alike. Another feature is that though the upper extremity continues to be directed vertically, the lower shows the beginning of the inward rotation. The same features are illustrated in a fetus of the 18 mm. C.R. length stage and there is pro-

bably a little more abduction of the pollex here as compared to the hallux. The heel is still not formed and the foot and the leg are in the same axis.

At the 28 mm. C.R. length stage (approximately 8th week), the differentiation into the three segments is a marked feature and the rotation of the lower extremity is complete. The shape of the hand and the feet are now different. The digits of the hand are spread out and are longer, the pollex

continues to be abducted and in a different axis from the rest of the digits and therefore cannot be seen. In the feet, the hallux has lost its abduction and is adducted to the other digits. The heel has appeared and the foot is at an angle to the axis of the leg.

At the 50 mm. C.R. Length stage (approximately 10th week) the same characteristics of the developing foot are evident in a more marked manner. The rotation of the foot is complete and it is at right angles to the axis of the leg. The heel is quite prominent. With further growth of the foetus in length as in 62 mm. stage, 85 mm. stage and 95 mm. stage, the development of the heel is seen to be progressive until at the 95 mm. stage it assumes adult proportions.

This ontogenetic study of the development of the foot reveals that the appearance and growth of the heel is the most important single factor in the formation and assumption of shape of the human foot. The development of the heel in the human foot corresponds to Wolff's law which says that the structure in a living individual conforms with the manner of its use. Such structural changes definitely tend towards improving the structure for a more efficient performance of the altered function. This structural peculiarity, if common to a class of animals, will if once acquired, be transmitted to subsequent generations and will make its appearance at a certain stage in the life history of the species. That the human foot, of all organs, should show the most pronounced structural characteristics seem obvious because of its specialized function and the nature of the burden it has to carry. No other part of body structure is affected by such violent forces as are exerted upon the comparatively small bones of the feet. In them the entire body weight is concentrated and its great stresses magnified by leverage. The average total of lbs. per minute transmitted by the foot bones is far greater than in any other member of the body. Consequently if any part of the entire skeleton may be supposed to

show the influence of function as a remodeling factor it would most surely and conspicuously be the foot.

According to Franz Weidenreich (1923), the calcaneus is the morphological kernel of the foot problem. Owing to the upright posture of man, the centre of gravity has shifted backward and this together with the necessity of obtaining a good leverage in the weight bearing foot causes the calcaneus to expand downwards and backwards. X-ray of the calcaneus shows that in man, the bony trabeculae are directed backwards and downwards instead of forwards and downwards as in the anthropoid apes. Lake (1937) makes an exactly similar observation, "the arch is developed because man when he adopted the upright position needed support for his foot behind the axis of the ankle joint in order to keep the line of the centre of gravity within the base. Upright position caused the large calf muscles to pull very strongly upwards and a great weight of leverage was required of the ankle joint. By Wolff's law, bone would be formed in the proper place and to the extent necessary to resist the stresses it encountered and the os calcis therefore developed in direct opposition to the stresses produced by the calf muscles in accordance to this law. The arch is not a sinuous curve but a triangular structure the very existence of which depends upon the development of the heel downwards and backwards." According to Keith (1933) the development of the arch is not only due to the development of the os calcis and the prolongation downwards and backwards of the heel but also due to the growth of the tarsal bones as a whole especially the astragalus, scaphoid, cuneiform, and cuboid.

To examine the architecture of the foetal feet, I made two preparations of each specimen of foetal foot (Fig. 33). One (A) was a sagittal section through the leg, heel and obliquely through the 1st metatarsal bone. My idea was to show the relative arrangement of the tuberosity of the os calcis, the astragalus, the scaphoid, the 1st cuneiform,



Fig. 33.

Sagittal section and dissection of a foetal foot, male, 9 months.

the 1st metatarsal and the phalanges of the great toe in one section and it was not possible to do that unless the section was oblique—because a vertical section through the 1st metatarsal would only pass through the sustentaculum tali of the os calcis as the tuberosity lies more laterally. The second specimen (B) was prepared by removing all the soft tissues from the sole of the foot, leaving only the ligamentous and the skeletal elements. 40 such specimens of different foetal ages were prepared (Table IX).

The smallest foot was of a foetus of 13 cm. C.R. length and the length of the foot was 2.35 cm. The longest foot was 15.5 cm. in length. In each specimen a number of measurements were taken. (1) Length of the foot being the distance from heel to the tip of the great toe. (2) The length of the os calcis being the distance from the heel to the centre of the talo-calcaneal joint. (3) The length of the tarsus being the distance from the heel to the centre of the cuneio-metatarsal joint. (4) The length of the 1st metatarsal bone. (5) The length of the 1st phalanx of the great toe. In addition measurements of the height of the soft tissues of the sole were taken in each specimen at 3 levels (a) at the astragalo-scapoid joint, (b) at the cuneio-metatarsal joint, and (c) at the metatarso-phalangeal joint (Table IX).

Examination of this series of dissected foetal feet would show that the longitudinal skeletal arch is present in every instance and the reason why they are not at once obvious is because they are hidden by the mass of fibro-fatty and muscular tissue.

To determine the disposition of the skeletal structure in still smaller feet, I collected a number of foetal feet of the stages of 28 mm., 50 mm., 62 mm., 85 mm. and 95 mm. C.R. length. Sagittal sections of these very small feet were made. As the feet of



14 cm  
C.R. Length

13 cm  
C.R. Length

13 cm  
C.R. Length



Fig. 34.

Section of feet of a 13 cm foetus stained by Indian ink method.

these fetuses were very small and the difference between the soft tissues and the cartilage was scarcely noticeable with the naked eye—I tried to find out something which will stain the soft tissues but will not stain the cartilage. Experimenting with different dyes, it was found, that Indian ink answered the purpose best. The dissected specimens were kept immersed in a solu-

TABLE IX

No	Age of Foetus	Sex	Cartilaginous arch	Length of Heel	Length of Tarsus	Length of Metatarsus	Length of 1st Phalanx	Height of Soft tissues			Length of Foot
								Astragalo-navicular Junction	Cuneiform Metatarsal Junction	Metatarsal Phalangeal Junction	
1. Full term	...	M	P	16mm	32mm	17mm	8mm	14mm	8mm	4.5mm	7.2cm
2. Full term	...	M	P	14mm	29mm	17mm	7.5mm	13mm	9mm	3.5mm	7cm
3. Full term	...	F	P	11mm	33mm	18mm	5mm	11mm	7mm	4mm	7cm
4. Full term	...	M	P	17mm	35mm	17mm	8.8mm	11mm	7mm	4mm	8.3cm
5. Full term	...	F	P	13mm	29mm	15mm	7mm	10mm	6.2mm	3mm	6.2cm
6. Full term	...	M	P	17mm	34mm	18mm	8mm	9mm	6.5mm	3mm	7cm
7. Full term	...	M	P	14.5mm	32mm	19mm	9mm	13mm	10mm	3.5mm	7.5cm
8. 8 months	...	M	P	12mm	29mm	15mm	6.8mm	9mm	5mm	3mm	6cm
9. Full term	...	F	P	16mm	33mm	18mm	11mm	—	—	—	7.1cm
10. 9 months	...	F	P	13.5mm	30mm	16mm	7mm	7mm	4mm	2.5mm	6.8cm
11. 8 months	...	M	P	14mm	30mm	15.5mm	7.5mm	10mm	6mm	4mm	6.4cm
12. Pre-mature 6 months	...	F	P	10.5mm	24mm	11.5mm	6mm	6mm	4mm	2mm	5.2cm
13. Full term	...	M	P	15mm	31mm	18mm	—	12mm	7.5mm	3mm	7.1cm
14. 9 months	...	M	P	14mm	30mm	15.5mm	7mm	9mm	6mm	3mm	6.2cm
15. 8 months	...	F	P	11.5mm	27.5mm	13.5mm	—	16mm	5.5mm	4mm	6.2cm
16. 6 months	...	M	P	12mm	25mm	14mm	6.8mm	10mm	6mm	3mm	5.5cm
17. 8 months	...	M	P	12.5mm	30mm	15mm	6mm	7mm	4.8mm	2.5mm	6.8cm
18. 6 months	...	M	P	9.8mm	24mm	13mm	8mm	9mm	6mm	3mm	5.2cm
19. 7 months	...	M	P	12.5mm	27mm	15mm	7mm	11mm	6.5mm	4mm	6.3cm
20. 6 months	...	M	P	10.5mm	23mm	13.5mm	8mm	8mm	4.5mm	2mm	5.6cm
21. 6 months	...	M	P	10mm	24mm	13.5mm	8mm	8.5mm	5mm	2.5mm	5.3cm
22. 7 months	...	F	P	12mm	30mm	15mm	8mm	8.5mm	6mm	3mm	6.2cm
23. 7 months	...	M	P	11.5mm	25mm	14mm	8mm	8.5mm	5.5mm	3.5mm	5.5cm
24. 6 months	...	M	P	13.5mm	30mm	17mm	9mm	11.5mm	6.5mm	4mm	6.2cm
25. 5 months	...	F	P	11mm	22.5mm	13mm	6.5mm	6mm	5mm	2mm	5.4cm
26. 6 months	...	M	P	11.4mm	26mm	13.5mm	6.5mm	6.5mm	5mm	1.5mm	5.7cm
27. Full term	...	M	P	14.5mm	29mm	16mm	7.7mm	16.5mm	6.5mm	3.5mm	6.6cm
28. Full term	...	F	P	13mm	30mm	17mm	9.5mm	10mm	4mm	2mm	6cm
29. 8 months	...	M	P	15mm	31mm	17mm	8mm	10mm	5mm	2mm	6.4cm
30. Full term	...	M	P	15mm	32mm	17.5mm	8mm	7.5mm	5.5mm	3.5mm	7.1cm
31. 5 months	...	M	P	5mm	14.5mm	7.5mm	4mm	6mm	4mm	2mm	3.4cm
32. C. R. Length 14cm	...	M	P	6mm	15.5mm	8mm	4mm	6mm	4.5mm	2mm	3.5cm
33. C. R. Length 13cm	...	M	P	5.6mm	12.5mm	6mm	3mm	4mm	3mm	1.5mm	2.5cm
34. C. R. Length 19cm	...	M	P	8.5mm	19mm	11mm	5.5mm	8mm	4.5mm	3mm	4.3cm
35. C. R. Length 13cm	...	M	P	6mm	12mm	6.5mm	3mm	6mm	3mm	1mm	2.5cm
36. C. R. Length 13cm	...	M	P	5.5mm	11mm	6.5mm	3mm	5.5mm	3mm	1mm	2.35cm
37. Full term	...	M	P	14mm	31mm	17mm	9mm	13.5mm	9mm	2.5mm	6.7cm
38. 2-years	...	M	P	25mm	54mm	27mm	14mm	17.5mm	10mm	3.5mm	11.9cm
39. 4-years	...	M	P	40mm	76mm	37mm	18mm	31mm	17mm	11mm	15.5cm
40. 1 year	...	M	P	19mm	39mm	23mm	11mm	13mm	7mm	7mm	8.7cm

tion of Indian ink for 24 hours and on the following day were washed in water and dried in absolute alcohol. It was found that the soft tissues had been stained deeply black and by contrast the cartilage looked white. The method was also very suitable for photographing the parts for the sharp contrast between the two tissues made them easily discernible (Fig. 35).

It will be seen that the arch is fully developed even at the stage of 28 mm. C.R. length and in it and in the subsequent stages, the inclination of the heel and contour of the longitudinal arch correspond to adult proportions.

It can be said therefore from this series of investigations that the skeletal structure of the human foot is disposed in the form of an arch from the stage of 28 mm. C.R. length, if not earlier. It is generally agreed that the anatomical bony architecture of a

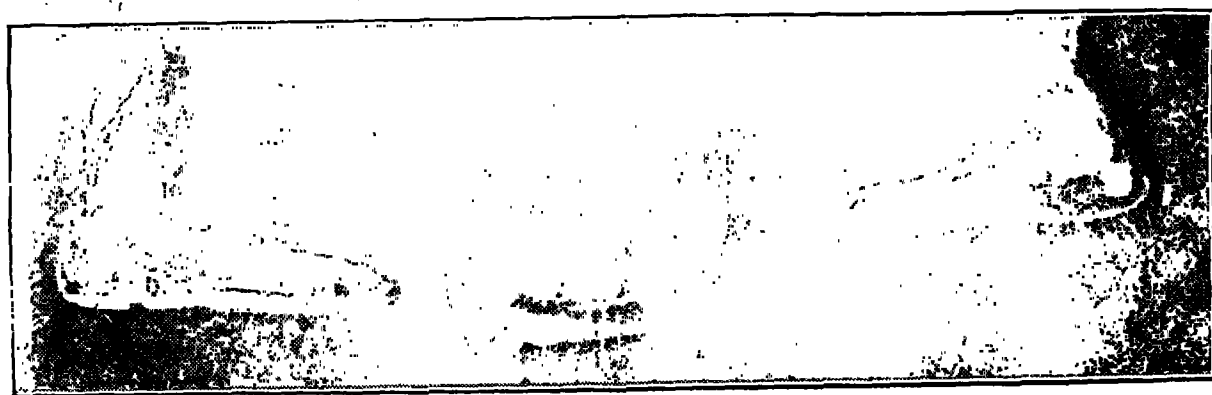
part, as seen in the adult, is defined in its cartilaginous precursor and however much the individual bones may undergo modifications in shape or size due to the stress and strain of the mode of life of the individual, these modifications only affect the details and the fundamental anatomical structure remains on the whole unaltered throughout life unless disturbed by a gross deformity.

If this be so, the longitudinal arch of the foot, as it is seen in the foetal feet from a very early stage, is a definite anatomical structure produced in its adult proportions as soon as the heel has developed in the foetal skeleton (28 mm. C.R. length). "The modifications which the individual bones undergo and the changes which these modifications produce on the arches are imposed on the skeletal form which is primarily an arched one." (Bruce and Walmsley—1938). This finding proves once again



28 mm C.R. Length

58 mm C.R. Length



85 mm CRL

62 mm CRL

95 mm CRL

Fig. 35.

Section of feet of very small fetuses stained by Indian ink method.

that the development of the arches of the foot cannot be ascribed to the postural tone of the antigravity muscles, since there can be no question of the postural tone at such an early stage of foetal life.

Certain other conclusions were deduced from this series of investigations. The average length of the heel, tarsus and the metatarsus as compared to the total length of the foot in foetuses above the stage of 20 cm. C.R. length are as follows:—

(1) The average length of the heel is 21% of the length of the foot.

(2) The average length of the tarsus is 44% of the length of the foot.

(3) The average length of the metatarsus is 26% of the length of the foot.

(4) The average length of the phalanx is 16% of the total length of the foot.

As regards the soft tissues, (1) the average height of the soft tissues at this stage at the level of the astragalo-scaphoid junction compared to the total length of the foot is 18%. (2) the average height of the

soft tissues at the cuneio-metatarsal articulation compared to the total length of the foot is 9%. (3) The average height at the metatarso-phalangeal junction to the total length of the foot is 4%.

For purposes of comparison I took similar measurements of the different constituents of the foot in a number of very small foetuses and in several adult men.

The readings obtained in the small foetuses are tabulated below:—

The average measurements of the different constituents in these ten very small feet were as follows:—

(1) Heel—14.5% of the length of the foot.

(2) Tarsus—35.4% of the length of the foot.

(3) Metatarsus—30.1% of the length of the foot.

(4) 1st Phalanx—21.1% of the length of the foot.

TABLE X

No.	Length of the foot	Length of the heel	Length of tarsus	Length of metatarsus	Length of 1st phalanx
1.	36mm	6mm = 16%	14mm = 38%	11mm = 27%	7mm = 19%
2.	24mm	3mm = 13	9mm = 37%	7.5mm = 31%	5mm = 20%
3.	30mm	5mm = 16%	11mm = 36%	9mm = 30%	6mm = 20%
4.	20mm	3mm = 15%	7mm = 35%	6mm = 30%	5mm = 22%
5.	40mm	7mm = 17%	16mm = 40%	11mm = 28%	7mm = 17%
6.	16mm	2.5mm = 14%	6mm = 34%	5mm = 31%	4mm = 22%
7.	18mm	3mm = 14%	6mm = 33%	6mm = 31%	4mm = 21%
8.	15mm	2mm = 13%	4mm = 31%	4mm = 31%	3mm = 25%
9.	15mm	2mm = 12%	5mm = 33%	5mm = 33%	4mm = 25%
10.	24mm	4mm = 16%	9mm = 37%	7mm = 29%	5mm = 20%

No.	Obtained from	Age	Length of foot	Length of heel	Length of tarsus	Length of metatarsus	Length of 1st phalanx	Astragalo scaphoid junction	Cuneio-metatarsal junction	Metatarso-phalangeal junction
1.	S. N. P. H. Morgue	35	210mm	49mm = 24%	98mm = 47%	52mm = 24%	25mm = 12%	30mm = 14%	15mm = 7%	10mm = 4%
2.	S. N. P. H. Morgue	42	200mm	48mm = 24%	96mm = 48%	50mm = 25%	24mm = 12%	26mm = 13%	14mm = 7%	8mm = 4%
3.	M. C. H. Morgue	26	250mm	54mm = 21%	110mm = 46%	56mm = 22%	28mm = 11%	24mm = 10%	16mm = 9%	10mm = 4%
4.	M. C. H. Morgue	50	220mm	50mm = 22%	104mm = 47%	54mm = 24%	28mm = 12%	25mm = 11%	12mm = 6%	6mm = 3%
5.	M. C. H. Morgue	54	180mm	40mm = 20%	82mm = 45%	44mm = 24%	20mm = 11%	16mm = 9%	8mm = 5%	6mm = 3%
6.	M. C. H. Morgue	23	190mm	42mm = 21%	84mm = 44%	48mm = 24%	22mm = 11%	24mm = 12%	10mm = 5%	6mm = 3%
7.	M. C. H. Morgue	20	176mm	38mm = 21%	84mm = 46%	44mm = 25%	20mm = 11%	10mm = 9%	8mm = 5%	4mm = 3%
8.	M. C. H. Morgue	27	230mm	52mm = 22%	110mm = 48%	58mm = 25%	30mm = 13	30mm = 13%	16mm = 7%	8mm = 3%
9.	M. C. H. Morgue	47	246mm	52mm = 21%	106mm = 44%	55mm = 23%	26mm = 10%	34mm = 13%	18mm = 7%	9mm = 3%
10.	M. C. H. Morgue	35	225mm	51mm = 23%	108mm = 46%	56mm = 25%	26mm = 12%	36mm = 15%	16mm = 7%	8mm = 3%

All these fetuses were below the stage of 20 cm. C.R. length. It will be seen that these measurements are different from those met with previously in fetuses of older age and new born babies. Here the length of the heel and the tarsus are comparatively less and those of the metatarsus and phalanges more than in the previous class. In fact it is seen that as the foetus increases in length and age, there is a progressive diminution of the lengths of the digits and metatarsus and progressive increase in the lengths of the tarsal section and the heel.

Similar measurements were taken in a number of adult amputated feet and the figures obtained are give below (Table XI). Included in the table also are vertical measurements of the soft tissues taken at three levels (a) at the astragalo-scaphoid junction, (b) at the cuneio-metatarsal junction, (c) at the metatarso-phalangeal junction (Table XI).

The diminution of the length of the digits and the metatarsals and increase of the length of the tarsal section and the heel is still more marked here. It can be said therefore that from foetal life onwards until adult proportions are reached there is a progressive diminution of the lengths of the digits and metatarsals and increase of the tarsal section and the heel.

Examination of the heights of the soft tissues in adult feet at the 3 levels mentioned and their comparison with those met with in foetal feet revealed what has been mentioned before that there is comparatively more soft tissue in foetal feet and this is the cause of the apparent flatness of the feet in fetuses and new born infants. At the astragalo-scaphoid junction of the adult foot, the average height of soft tissue is 11%, at the level of the cuneio-metatarsal junction the average height is 6.5% and at the metatarso-phalangeal junction the average is 3.5%. Comparison of these figures with those in foetal feet would show that at the 1st two levels, the proportions of soft tissues are much less.



### The stages of the development of the longitudinal arch of the foot among the primates

To study the development of the longitudinal arch of the foot in different animals and especially among the higher primates I attended the Anthropology and the Zoology departments of the Calcutta University. I was able to collect specimens of the skeletons of the foot of the following animals and their examination and comparison with each other and with those of the human foot revealed interesting features.

The animals examined were:—

- (1) Lemuroide—Lemurs.
- (2) Cercopithecidae—Macque, Baboon, Langurs.
- (3) Hylobatidae—Gibbon.
- (4) Pithecanthropoidae—Chimpanze.
- (5) Simiidae—Gorilla.
- (6) Homidae—Man.

#### LOWER PRIMATES

(1) *Lemuroid Class*.—One specimen of this class was seen in the museum of the Zoological department of the University of Calcutta (Fig. 36). The characteristics of the skeleton foot of this class to be noted

are (a) wide divergence of the hallux and its abductability. These animals are arboreal in habits and live on tree tops amongst branches that are quite large for their feet. They develop therefore the type of grasp that is known as the clinging type. (b) There is marked torsion of the hallux and the outer 4 metatarsals. This torsion of the metatarsals also helps the clinging type of grip. (c) The digital and metatarsal bones are very long compared to the tarsus. (d) Another characteristic to be noted is that the line of leverage passes through the 3rd metatarsal bone which is also the longest. This is known as the primitive line of leverage as contrasted with the humanoid line of leverage which passes through the second metatarsal bone. (e) The heel is very small and primitive. (f) There is no arch.

The lemur is a very interesting animal in the sense that it is considered by some persons to be the nearest approach among the present day animals to a creature which resembles man's ancestors at the time when the humanoid stock separated from the apes—perhaps 2,000,000 years ago. At this very early period, the primitive forerunner of man was arboreal in habits and the anatomy of the foot therefore showed mainly arboreal characters.

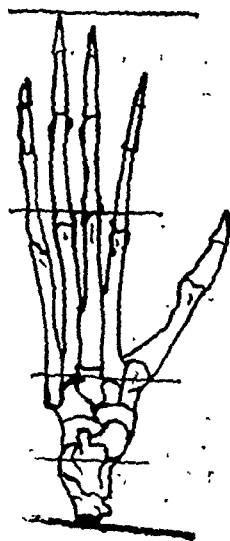


Fig. 36.  
Skeleton of lemur's foot.

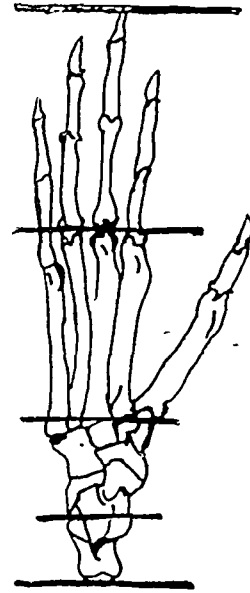
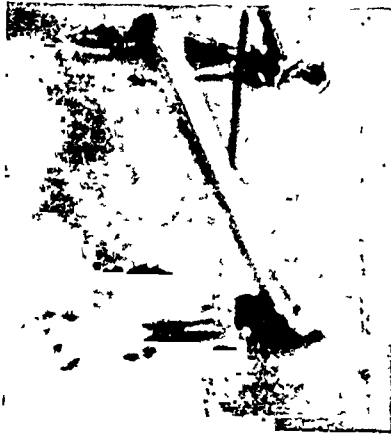


Fig. 37.

Skeleton of foot of baboon.

(2) *Baboon*.—This animal belongs to the group of catarrhine (old world) primates. As a rule the catarrhine primates are older and therefore more terrestrial in their habits than their platyrrhine (new world) relatives and this difference in the mode of their living is evident in their foot skeleton (Fig. 37). The characteristics of the baboon's foot are the following:—

- (1) The length of the metatarsals is marked and there is comparative shortness of the phalanges.
- (2) The absence, or the very small amount of torsion of the outer metatarsals.
- (3) The line of leverage is still primitive and passes through the third metatarsal bone which is still the longest bone.
- (4) The tarsal segment is still small compared to the fore part of the foot.
- (5) The hallux is abducted and shows torsion.
- (6) The heel is more prominent than in the lemur's foot.
- (7) There is no arch.

It will be seen therefore that the baboon's foot shows a mixture of arboreal and terrestrial characters. The arboreal characters are manifested by the long fore foot, the abducted hallux showing torsion which indicates grasping function and the terrestrial characters are seen in the short phalanges and the prominent heel. "It is evident therefore that this species is unquestionably derived from arboreal ancestors and that they adopted ground habits before they had changed from the primitive to the humanoid line of leverage" (Morton).

(3) *Macacus*.—Characteristics of the monkey's foot are very nearly the same as those of the baboon and show the same ground ape features with lengthening of the metatarsals and comparative shortening of the digits (Fig. 38). There is less abduction of the hallux and torsion is very little. The fore part of the foot consisting of the digits and metatarsals are much longer than the tarsal part and the heel is horizontal as in the previous animals. The foot on the whole is of an arboreal type with terrestrial modifications. There is no arch.

(4) *Langur*.—The characteristics of the Langur's foot are practically the same as in



Fig. 38.  
Skeleton of foot of macacus.

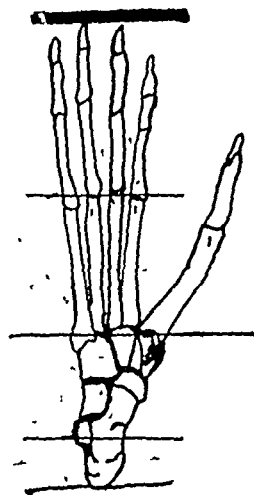


Fig. 39.  
Skeleton of foot of langur.

the macacus. The digits and the metatarsals are very long, the primitive line of leverage through the 3rd metatarsal still persists and there is abduction and torsion of the great toe; the heel is small and horizontal (Fig. 39).

#### HIGHER PRIMATES

(5) *Gibbon*.—In contrast with the cynomorphae, such as the monkeys, typical

quadrupedal animals, a gibbon, along with the orang, chimpanzee and gorilla belongs to the sub-class of anthromorphia, i.e., specialised arboreal animals which when on the ground habitually assume semi-erect posture, supporting the weight of the forepart of the body upon ends of the fingers or more frequently upon the knuckles—the thigh and the leg being much shorter than the arm and the forearm. The



Fig. 40.

Skeleton of foot of gibbon.

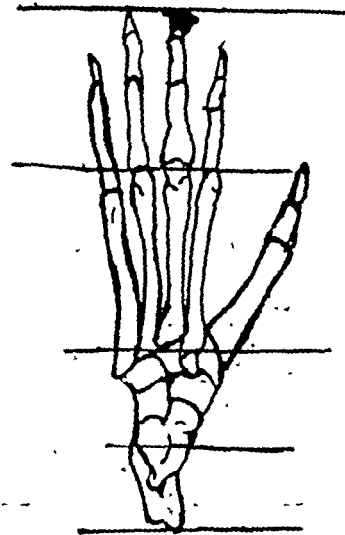
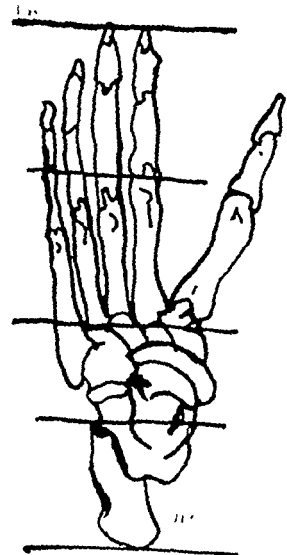


Fig. 41.

Skeleton of foot of chimpanzee.



gibbon however is a very small animal and lives an arboreal existence most of the time. The characteristics of its foot are the following (Fig. 40).

- (1) The humanoid line of leverage. The line of leverage for the first time passes through the second metatarsal bone which now becomes the longest bone.
- (2) The long digits and metatarsals and their marked torsion. Both the

digital segment and the metatarsals are very elongated and this and their torsion are adapted to maintain the erect posture of the body by their grasp upon the supporting branch.

- (3) The tarsal bones are short, and the heel is small and horizontal indicating lessened leverage demand upon the calf muscles.
- (4) There is no arch.

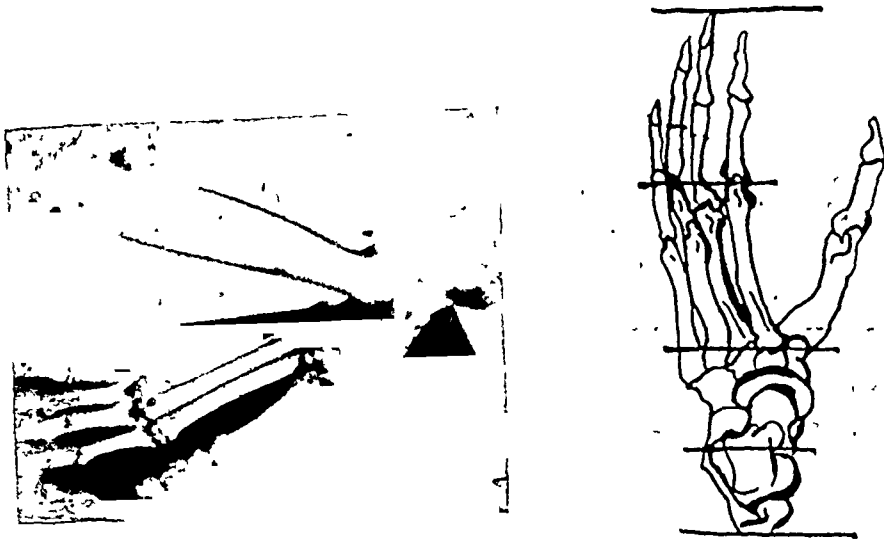


Fig. 42.

Skeleton of foot of gorilla (obtained from Zoological Dept., Benares University).

(6) *Chimpanzee*.—The chimpanzee is an animal higher than the gibbon in the anthromorphus scale and its foot, therefore, though resembling the gibbon in its essential characters, show some advancement in its terrestrial modifications (Fig. 41).

- (1) The bones are more massive though not to the degree seen in the gorilla.
- (2) The digital and metatarsal segments specially the former are shorter than in the gibbon.
- (3) The first metatarsal still shows abduction and torsion indicating grasping function which also is evident from the torsion of the other metatarsals.
- (4) The tarsal bones, as in the gibbon are comparatively shorter than in the gorilla and man.
- (5) The heel, though longer than in the gibbon, maccasus or baboon is still comparatively short and the slight increase of its length indicates greater use of leverage function.

(7) *Gorilla*.—The gorilla's foot is of fundamental importance because it reveals characteristics that show the stages of evolution of the foot clearly and in fact the gorilla's foot is a transitory stage between the anthropoid apes and man (Fig. 42). The same arboreal characteristics seen in the foot of the chimpanzee are still present in a subdued degree but are overshadowed by other characteristics, that show that it has adopted a terrestrial mode of life and upright posture. "The gorilla has evidently become a ground dweller when his increasing bulk unfitted him for life amongst the trees" (Morton). The differences between the feet of the chimpanzee and the gorilla must therefore be associated with their change of habits and reveal the effects of terrestrial usage upon an arboreally developed foot. Compared with the chimpanzee the gorilla's foot (obtained from the museum of the Zoological department of the Benares Hindu University) shows more massiveness of structure and increase in bulk specially the heel. The abduction of the great toe though present is reduced and the hallucial and digital metatarsals show no torsion nor is the plantar curvature of the phalanges (seen in the chimpanzee's

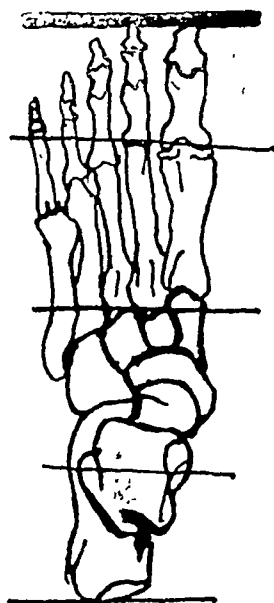
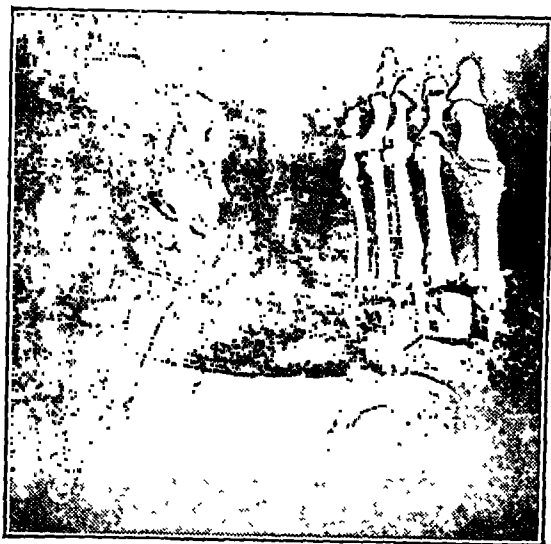


Fig. 43.

Skeleton of foot of man.

foot) present here. The plantar surfaces of the digits are therefore presented flatly to the ground.

The os calcis, especially the heel, is markedly strengthened and lengthened and this implies increased foot leverage. The comparatively short heel of the chimpanzee's foot indicates the low grade of leverage effort that characterizes the arboreal foot. In the gorilla a marked difference is found both in the length and the massiveness of the heel. Increased massiveness may be accounted for by the plantigrade posture of the foot but the lengthening of the heel is obviously the result of improved leverage function. Another very significant difference presented by the gorilla foot is the early development of the elements of the longitudinal arch. The structure as manifested in the human foot is a distinct product of improved terrestrial leverage function and its presence in a primitive form in the foot of the gorilla indicates early attainment of the same quality in that animal.

(8) *Human foot* (Fig. 43).—The modifications seen in the gorilla as the result of terrestrial habitat are carried to a much

further degree in man and the additional differences are the result of its "high degree of specialisation and of having started its terrestrial development from a more primitive type of arboreal foot than did the gorilla" (Fig. 43). The gorilla, in spite of its upright posture, is an anthropomorphous animal and makes use of its long upper extremities in locomotion; but man is entirely dependent on his feet and the upper extremities take no part in locomotion. It is no wonder therefore, that the human feet attain such specialised development and the longitudinal arch, which is an expression of grace and economy of effort in terrestrial animals depending on increased leverage, attains such predominance.

**Digital Segment.**—The digits are very short, specially the middle and the distal ones. The plantar surfaces are directed completely downwards.

**Metatarsal area.**—Torsion of the metatarsals is absent. The bones are reduced in length and are massive.

**Hallux.**—Abduction is absent. Its large size indicates the strength that is put upon this segment of the foot. There is no torsion. The outer side of the foot was the

predominant section in the lower primates, and therefore the outer metatarsals were more massive in size. As the animal began to adopt a terrestrial mode of life, the earlier supinated posture was modified by pronation and the inner side of the foot became more important and bore increased strain. This is seen to a lesser extent in the gibbon but in increasing proportions in the chimpanzee and the gorilla but it attains its highest development in man where the first metatarsal is about twice the size of the other outer metatarsal bones.

**Posterior Tarsal Section.**—The heel is massive and directed downwards and backwards. It is modified for weight bearing and also sustains the strong upward thrust of the calf muscles.

**Longitudinal arch.**—The longitudinal arch attains its greatest development in the human foot. It was seen that the arch made its first appearance in the gorilla foot although it was very small in height and not so efficient. A well developed arch is an expression of the judicious use of foot leverage.

This can be well illustrated by watching the gait of two persons—one with well developed arch and another with low arch and flattened feet. The former walks with easy grace. The centre of gravity is kept in advance and the two parts of the foot, the anterior and the posterior, act as two arms of the lever with the leg as the fulcrum. The impulse which is given to the body weight by each foot seems automatically to carry the foot forward into the next step. The other person has a different gait. He walks with an effort with shuffling foot steps. His centre of gravity is not kept in advance and instead of being impelled directly forwards, it is merely shifted obliquely from one foot to another. There is no leverage effort. Each foot has to be elevated and then shifted by voluntary effort to a forward position to receive the body weight.

The first example of gait is an illustration of judiciously used foot leverage for

which a well developed arch is necessary. This we find in modern man. For its development, comparative atrophy of the anterior section i.e. the digital and metatarsal segments and hypertrophy of the posterior segment i.e. the tarsal section and the heel is necessary, as also the inclination of the heel downwards and backwards. During stance the weight of the body is transmitted by the tibia to the top of the arch and is distributed in equal proportions between the heel and the metatarsal heads. During locomotion—at the stage of lifting the heel from the grounds and swinging the other leg forwards—all the weight is transferred to the metatarsal heads, especially the first two thereby putting a strain on them and on the arch. The contractural tone of the leg muscles now come into play and takes off some of the strain and thus relieves the arch.

The second example of gait may be considered comparable with the early stages of leverage development and a low arch—as we find in the gorilla. Evidently the first propulsive efforts in this ancient ground-dweller were weak and associated with a shifting of weight from one foot to the other. Continued exercise in a group of active and energetic animals however, would stimulate the development of leverage action with a subsequent lengthening and inclination of the heel.

The purpose of this brief review of the skeletal characteristics of the primate feet including those of the anthropoid apes is to show in these animals, as they ascend in the primate scale, the gradual development of those features which are peculiar to the human feet. It has been said that man arose from a stock which separated from the common ape stock in the oligocene period perhaps 2,000,000 years ago. But even so, one is struck by the close resemblances between the foot of the gorilla (which is the highest developed anthropoid) and the human foot and what differences there are, are probably due to the latter's longer terrestrial existence and longer bipedal mode of locomotion. The differences be-

tween the primate and the human feet may be summarised as follows:—

#### PRIMATE FOOT

- (1) The long digital and metatarsal segments.
- (2) The wide abduction of the great toe—the wide range of its movements and the possibility of its adduction to the other toes.
- (3) The torsion of all the metatarsal shafts including the first—that of the first being in opposite direction to the outer four.
- (4) Along with the lateral torsion there is plantar curvature of the metatarsal shafts and phalanges.
- (5) Compared with the metatarsals, the tarsal bones are short and insignificant. This is especially so in the case of the os calcis whose tuberosity is rudimentary and directed horizontally.
- (6) There is no arch except its very primitive appearance in the foot of the gorilla.

The first four characteristics reveal the presence of an anterior clasp arch in these primate feet which is so very necessary for the arboreal existence of these animals. The mode of regression of this anterior clasp arch can be read from the formation and arrangement of the human metatarsal and toes. "The metatarsal bones and basal phalanges show, although to a varying degree, the original bend towards the plantar aspect of the foot. The rotation of the metatarsals is also evident; these are clearly twisted in their capitulum when compared with their basal parts and this in such a way that the capitulum of the metatarsals 2 to 4 point medially while the metatarsal 1 behaves exactly in the opposite way pointing laterally," (Wiedenrich—1923).

The longitudinal arch is the latest acquisition in the foot of the higher primates. As

has been stated before, it is the result of upright stance and progression and is brought into being by the leverage effort of terrestrial locomotion. Owing to the upright posture of the animal, the centre of gravity has shifted backwards and to this is added the necessity of obtaining good leverage in weight bearing feet. The upright posture causes the large calf muscles to pull strongly upwards and a great weight of leverage is required of the ankle joint. By Wolff's law, bone would be formed in the proper place and to the extent necessary to resist the stress it encounters and the os calcis therefore is prolonged downwards and backwards to resist the great additional weight thrown on it in walking. The prolongation of the os calcis produces the heel and is the most important factor in the appearance of the longitudinal arch. The longitudinal arch is present in the foot of the gorilla in a primitive form. It is conceivable that if the gorilla continues to exist for some hundreds of years and to practice bipedal upright locomotion without the support of its hand—the arch in its feet would partake of human characteristics in their entirety.

It has been noted in the few incomplete parts of the human fossil skeletons (which have been discovered till now), that the principal characteristics of the different constituents of the foot and especially of the arch remain the same as in recent man—(Wiedenrich—1933). The conclusion therefore seems justified that these fossil hominidae must have walked upright.

One other conclusion seems to justify itself if we examine the stages of development of the primate foot, and compare them with the development of the foot in the foetus and in infants and children upto the adult stage. In both instances, one is struck with the close similarity of progress to the adult human type. Thus the shortening of the forepart of the foot, the increase in length and strength of the tarsal section, the increasing development of the first metatarsal and its abduction and fixation to



the other metatarsals, the gradual importance of the medial side of the foot and the culmination of all this, the appearance and development of the longitudinal arch of the foot, are common in both instances. One can say therefore that in this respect ontogeny has recapitulated phylogeny.

### SUMMARY AND CONCLUSION

The antagonistic view points between the two schools of thought as regards the rigidity and permanence of the longitudinal arch of the foot have been mentioned. To the school to which Bankart, Wiles and others belong, the normal feet should be perfectly supple and capable of altering the height and the shape of its arch at will. The apparent rigidity and the unyielding arch seen in human foot is ascribed by them to be due to the result of constant use of unyielding foot wear and they consider this as an abnormality. The other school which includes Lake, Morton and others consider the want of suppleness in adult human feet as perfectly normal and as Lake puts it "the evolutionary destiny of the human foot is to the production of a rigid structure having an arched form but devoid of any movement other than those at the ankle and the toe joints."

From my investigations I am inclined to the latter of the two views. I have found that there is no difference so far as rigidity and inelasticity is concerned between the feet of bare footed people and those who wear shoes continually. I have further shown that the feet of those who wear shoes continually show a peculiar characteristic as regards the arch. There is on the average a slight lowering of the arch and some abduction of the fore part of the foot.

My investigations have further shown that the postural tone of the antigravity muscles are not responsible for the maintenance of the arch. There is acute difference of opinion as regards this point between the same two schools of thought. I have shown that the abolition of postural tone has not the slightest effect on the arch—that under

those conditions in which the postural tone might be expected to be diminished or absent, the arch remains unaltered, and that in babies and infants in whom the postural tone is said to be absent and in whom the arch has seemingly not developed, the apparent absence of the arch is due really to the well developed pad of fat and the excessive amount of soft tissues which hides the arch.

I have further shown that the real factors in the maintenance of the arch is the bony configuration of the medial side of the foot and the strong ligaments binding the bony frame work. Loss of this ligamentous influence causes more or less depression of the arch. The muscles at best are of secondary help in taking off some of the strain during locomotion.

I have pointed out the gradual stages by which the arch appears in children's feet and have shown that the full development of the arch is not complete before the 6th year.

I have dissected a series of fetuses' feet—the smallest being of 28 mm. C.R. length and have shown that the cartilaginous frame work of the arch is evident from that stage or even before. I have also made a series of comparisons as regards the different constituent elements of the feet in these embryos and have shown that throughout foetal life there is a progressive diminution of the digital and metatarsal elements of the foot and increase of the tarsal elements and the heel. The same is true for the infants and the children's feet as they increase in years and the same changes continue until adult proportions are reached. I have also examined the skeleton of the foot of some of the primate animals—a few of the lower primates and most of the higher primates and I have pointed out their individuals' characteristics. I have shown how these characteristics vary with the mode of living of these animals, their habitat and their manner of locomotion. It was seen that as these animals discarded their arboreal existence and took to terres-

trial abodes, their feet exhibited certain characteristics akin to those in human feet. As the animals adopted the upright posture (as in the gorilla) the resemblance became still closer—the heel became prominent, the tarsal section increased in length and the abduction and the torsion of the great toe decreased and it increased in strength and prominence. It has been said also that the longitudinal arch manifested itself in the gorilla foot.

From all these considerations, it can be concluded that the longitudinal arch of the foot in its fully developed state is a human characteristic — permanent and rigid — brought into being according to the tenets of Wolff's law—because of man's terrestrial habits and upright posture. For the appearance of the arch, the increase in the size of the heel, its inclination, the increase in the tarsal section of the foot, the diminution of its fore part and the increased strength of the medial side of the foot are responsible; for its maintenance the bony configuration and the ligamentous support are the important factors. The contractural tone of the muscles may be of some help during locomotion but the postural tone is ineffective.

### WRITER'S CONTRIBUTION

1. A critical study of the foot prints of barefooted people and those who wear shoes continually pointing out the difference between them as regards the lowering of the arch of the foot and the abduction of its forepart in the latter class.

2. A series of examinations in which the influence of the postural tone of the muscles on the arch of the foot was determined.

3. Experiments illustrating the influence of the ligaments in the maintenance of the arch of the foot.

4. A series of examinations showing the gradual development of the arch of the foot from birth up to the age of 8 years.

5. Embryological investigation of the foetuses' feet upto the stage of 28 mm. C.R.

length pointing out the presence of the cartilaginous frame work of the arch.

6. It was determined by comparison of the different constituent elements of the foetal feet with those of the adult feet, that, as the feet increased in length, the different constituent elements underwent changes which corresponded with those in primate feet as they developed into higher stages.

7. Measurements of the heights of soft tissues in foetal and infant feet at different levels and their comparison with those in adult feet showed how the arch is hidden by the excessive soft tissue element in the former.

8. Examination of the skeleton of the foot of several of the lower and higher primate animals and their comparison with the human foot as regards the different constituents of the foot and the longitudinal arch.

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# URETER TRANSPLANTATION IN CANCER OF THE BLADDER

by N. D. LAKHANI.

## *Preamble*

Malignant disease of the urinary bladder remains a formidable proposition to-day. The role of radiotherapy as a palliative measure of limited value is generally recognised now. At a comparatively recent meeting of the urological section of the Royal Society in London; urologists and radiosurgeons reviewed their experiences in bladder cancer. Pure radiotherapists were also present. It was generally accepted that radiotherapy whatever the mode of application, has proved itself to be a complete failure and the only possible hope for cure, with our present and incomplete knowledge of cancer, lies in radical cystectomy in the female and cystovesiculoprostatectomy in the male. This conclusion has been a great incentive in the choice of this paper, as it is only by making the preliminary ureter transplantation a success that radical extirpation of the disease can be anticipated.

The implantation of the ureter into another part of the bladder (ureteroneocystostomy) may be suitable for the rare case of localised vesical cancer situated in the vault of the bladder. The ultimate results of partial and hemicystectomy are so poor that any surgical intervention for bladder cancer should aim at nothing else than a radical cystectomy. The situation is comparable to the choice between a radical mastectomy or local removal of the lump for a malignant condition of the breast.

Deviation of the ureters in the loins and on the anterolateral aspects of the abdominal wall have been practised by Henry Wade and others. The technique of the operation is simple and the urine can be collected in rubber reservoirs. The discomfort to the patient is the same as after a nephrostomy and with increasing experi-

ence, the Edinburgh school has turned in favour of ureterocolic implantation.

Transplantation of the ureter in various parts of the large intestine has been tried by many workers. Makkas suggested the caecum as the new bladder and performed rather a complicated operation for the purpose. Sampson Handley transplanted it directly into the caecum but absorption of the nitrogenous constituents of urine from the large intestine eventually proved fatal. In a case operated upon recently with which I was concerned, this site was used (patient with imperforate anus, colostomy and pathological fixation of the colon) and she died of typical uraemia during the first week after the operation. Transplantation of the ureter in the pelvic colon is well tolerated by the animal economy. The colonic mucous membrane being developed from the entoderm appears to be designed by nature to take over the reservoir function of the bladder and get readily adapted to this new urinous environment. This embryological fact and the clinical successes attendant upon this deviation of urine explain the current trend of surgeons all the world over towards ureterocolic method of transplantation. The scope of this paper is confined to this method.

## *Evolution of the operations*

In 1851, John Simon, then surgeon to St. Thomas' Hospital, transplanted the ureter into the rectum. This was a bold undertaking in those days, when even the removal of a sebaceous cyst was apt to be followed by erysipelas and prove fatal. Pasteur and Lister were still to expound their discoveries on fermentation and anti-sepsis in the next decade. The year 1870 may be regarded as the pivotal point in the second half of the nineteenth century. The Franco-Prussian War gave opportunities to test out the Listerian hypotheses. Surgery marched one step forward and men like Sir

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The author is grateful to Prof. Grey Turner for guidance and encouragement given for this study.

Thomas Smith (1878), Chaput (1894), Trendelenburg (1895), Tuffier and Chalot (1896), and others interested themselves in this branch of surgery and laid down the foundations for future work.

The failures following these operations were too numerous and the operative mortality appallingly high. It was precisely these failures and a critical analysis of them that revealed the dangers associated with the operations, stimulated the methods for safeguards and lowered the mortality of nearly a 100% to the present average figure of 30—35%. These pioneers opened new paths for further investigations in this and related fields of experimental surgery.

The names of Sir Harold Stiles and Coffey are intimately associated with the ureterocolic operations and the work on the lines chalked out by them is carried on by men like Grey Turner, Clifford Morson, Bernard Ward, Jewett, Cabot, Priestley, Strom and many others.

Experimental work has been carried out chiefly on dogs. The canine rectum is straight and very suitable for such experimental purposes. The principles of the modern operation described later in some detail are derived from a co-ordinated synthesis of these experimental and the post-mortem findings in the human subject. Animals surviving the operations show manifestations of recurrent ascending urinary infections, hydronephrosis and urinary calculi.

#### *Arterial supply of the pelvic ureter*

In the majority of specimens specially injected to demonstrate this, the injection mass from the internal iliac artery is visible in the periureteral vessels up to the point of bifurcation of the common iliac. This represents the supply to the terminal 4 inches of the ureter. The distribution occurs via the superior vesical and middle haemorrhoidal arteries. It is interesting to observe an accessory short but constant ureteral branch arising from the superior

vesical near its origin. These vessels course downwards along the ureter from the pelvic brim to the vesical end, the upper 2½ inches of this course being reinforced by tributaries from the internal spermatic artery. This anatomical fact explains why, with ordinary care the blood supply of the transplant is satisfactory.

Very occasionally, however, the principal vessels join the ureter at the vesical end and ascend upwards and in such circumstances, they would be damaged during the division of the ureter, with sloughing and peritonitis as the invariable sequelae. Fatal outcomes in such cases have shown that the necrosis is confined to the terminal 1½ inches. Should such an anomaly be suspected during the operation, this part should be excised and the transplant made at a higher level than usual.

#### *Principles of the main operations*

Simon brought about a fistulous communication between the ureter and the rectum by a tight ligature introduced with the help of an ingenious device. The patient who survived the operation for a time, died of ascending urinary infection and calculi. The rectum appears to be the ideal site for transplantation but is far too low to satisfy the modern requirements for the successful performance of the operation.

Smith used the posterior aspects of the ascending and the descending colon, doing the operation in stages. The subsequent post-mortem findings of the recorded case show that the left ureter, which was first transplanted, was obliterated by scar tissue; the left kidney was atrophied and the immediate cause of death was uraemia resulting from compression of the right ureter by sutures. The method never received any encouragement.

Trendelenburg laid stress on the importance of ascending urinary infection and he utilised a part of the bladder wall to provide a valvular mechanism.

Cuneo transplanted the ureter in an isolated loop of the ileum, of which the

mesentery was intact. One end of this ileal loop was closed and the other was anastomosed to the rectum.

The Makkas principle was illustrated in an attempt to produce an entirely new and independant urinary bladder, with blood supply, innervation and voluntary control. The caecum was isolated from the ascending colon and terminal ileum by division and an ileocolostomy was performed. The operation ended with an appendicostomy and the caecal cul-de-sac was rendered as sterile as possible by repeated irrigations through the fistula. The ureters were then transplanted in the caecum.

The lessons from these different operations clearly pointed to the lower part of the large intestine as the most convenient site for future attempts and brought home that ascending urinary infection and peritonitis were the real formidable risks and must be prevented in future.

The operations devised by Stiles and Coffey take these factors fully into account and by a combination of the Stiles-Coffey principles, the margin of safety becomes wide and the operation which belonged to the realm of special urology, can now be handed over with safety to the general surgeon, after the lapse of nearly a century of trial and error.

*Stiles' operation*: This was introduced in 1907. The divided end of the ureter was brought into the lumen of the pelvic colon through a transverse incision in the taenia and anchored half an inch below this point by fixation sutures passed through the bowel from within outwards. The site of the bowel incision was invaginated by a series of purse-string sutures, producing a Kader-Senn effect. Stiles paid meticulous attention to the fixation of the ureter but none at all to the provision of effective drainage into the bowel.

The traditions of the English Royal College of Surgeons are centred round the teachings of John Hunter, and one of these which has become classical is: "Living

matter by itself has mastered the art of healing; if men are to become surgeons, they must learn their art by studying the surgical ways of living matter." Grey Turner who was a great student of Hunter and later destined to deliver the Hunterian Oration of the College, pondering over our problems in the light of the above aphorism, suggested that if the ureter were brought with an obliquity into the bowel, as it emerged from the posterior abdominal wall, extrinsic obstruction would be eliminated and better drainage to the flow of urine would be provided for. Stiles incorporated this in his technique and buried about one inch of the ureter on the surface of the bowel wall by interrupted sero-muscular sutures, the principle employed now being that of Witzel for gastrostomy and enterostomy.

Charles Mayo improved upon this by introducing a catgut guide in the lumen of the ureter to overcome the effect of obstructive oedema.

*Coffey's operations*: To reduce the risks of ascending urinary infection and obstructive uraemia to the minimum, Coffey laid the ureter in an oblique fashion as Grey Turner suggested but secured additional safety against peritonitis and a valvular effect, by making a submucous bed in the bowel.

In the early twenties of the century the two ureters were operated upon in stages. This meant loss of time, so invaluable in malignant disease. Coffey was not satisfied with Mayo's catgut guide as a guarantee against possible effects of oedema and improved upon his technique by introduction of a catheter in the ureter at the time of operation, now doing both the ureters simultaneously (1925). He combined this with colonic lavage before and during the operation and considered this as the secret of the improvement in results. The actual operation may be epitomised thus. Rubber tubes or catheters are introduced 15 cms. up the ureters and held in position by stitches. A sigmoidoscope is introduced on the ope-

rating table and the bowel is washed and packed with sterile ribbon gauze. The pelvic colon is now opened in the usual oblique manner and the mucosa in the lower part of the bowel wound is incised. A knuckle of gauze packing is brought out and the ends of the catheters are anchored to this. When the gauze is pulled out, the ends of the catheters emerge at the anus externally. The catheters become loose in 10—12 days and could be easily removed. Should, however, these get blocked earlier by phosphatic deposit etc. the situation becomes grave and fatalities are known to occur.

Still later, Coffey devised a third method wherein he carried out the operation in stages. Here he divided the vesical end of the ureter between ligatures and laid the ureter in a submucous bed, transfixing it through the mucosa by a double thread. The thread was tied tightly in the hope that a fistulous communication would result later.

Coffey's principles are very sound and are accepted generally to-day. Surgeons of experience, however, are finding that they can now transplant both the ureters simultaneously with equally good results without the paraphernalia of tubes, catheters, sigmoidoscope etc.

#### *Routine management of a given case based on Personal Experiences*

The patient is admitted to the hospital at least ten days before the contemplated operation. Routine clinical examination of the abdomen, pelvis and the body generally for any possible metastases is carried out. Cystoscopic examination will probably need a spinal anaesthetic, as the bladder is irritable and the growth readily bleeds rendering the field haemorrhagic and opaque. Most urologists depends upon the cystoscopic appearances of the growth for diagnosis and in a typical case this would be ulcerated, sessile, covered over with phosphatic incrustation, causing infiltration of the adjacent bladder wall and generalised cystitis. The tendency for the lesion

to bleed after cystoscopy confirms its malignant nature. Biopsy as a diagnostic measure in cancer of the bladder is not popular beyond the U.S.A. The late Swift Joly and his colleagues at St. Peter's Hospital found such biopsy to be of very little value. Examination of the urine, blood chemistry, blood group, intravenous pyelography and plain X-Ray of the chest (sometimes demonstrating unsuspected secondaries) and of doubtful osseous lesions cover pretty well the routine accessory investigations. On rare occasions where a pyonephrosis is suspected ureteral catheterisation may be resorted to.

During this period the renal function is brought to the optimum level and a urinary output of 75-80 ozs. per day in cold climates such as that of England may be regarded as satisfactory. The most reliable single index of renal function is the figure for the 24-hour output. If this is poor (below 50 ozs.) or there is a co-existent pyonephrosis, a preliminary nephrostomy is indicated. I can well remember a lady so treated celebrating her eightieth birthday in the hospital while awaiting her discharge after total cystectomy.

Immediate preoperative preparation consists in the administration of one ounce of castor oil forty-eight hours before operation and an enema on the night before. This special preparation diminishes the troubles associated with distension of the bowel during and after operation.

Frequent bladder washes are unnecessary except in cases with severe haematuria.

General care is directed towards adequate nutrition and correction of existing anaemia. Use of sulphonamide group of drugs to counteract urinary infection is reserved for the postoperative phase and in this respect resembles the use of quinidine for toxic goitre cases after subtotal thyroidectomy. Some degree of cystitis is nearly always present but is not of any great moment. The fearful complication of



ascending urinary infection from the bowel is best prevented by adequate operative technique and diuresis, and little reliance should be placed on drugs or bladder washes.

*Some features in the operation:* Whatever the actual technique employed, all are agreed that the following criteria should be fulfilled. (1) Provision of good drainage for the urine to flow from the kidney to the bowel, this being achieved by avoidance of ureteral compression, angulation and stomal oedema. Ascending urinary infection does not occur in cases where drainage is good and taking place all the time, (2) absence of tension at the site of anastomosis and (3) preservation of the blood supply of the ureter to prevent sloughing and peritonitis. Two important questions have to be considered before the actual operation. These are: (1) Should the two ureters be dealt with at the same time? and (2) Which is the best site in the pelvic colon for our purpose? With experience, the operative mortality consequent on a bilateral operation is not increased. The performance of the operation does not take more than an hour and a half at the most and we are saving valuable time for the more important second event of total cystectomy. The right ureter is transplanted first and the left afterwards at a higher level. The sites generally chosen in the pelvic colon are  $2\frac{1}{2}$  and 4 inches above the pouch of Douglas for the right and left ureter respectively. Both the ureters are transplanted on the same side of the bowel viz. the right side and for this purpose the left ureter would have to be negotiated through the pelvic mesocolon. These are general observations and in any given case the site should be such as would enable the ureters to lie snugly at the conclusion of the operation.

The following are the main points in the actual procedure:

1. Catheterisation of the bladder on the operating table before the commencement of the operation.

2. Exploration of the abdomen by a midline incision extending from the umbilicus to the pubis. Search should be made for secondaries in the liver, peritoneum and lymph nodes in the pelvis. The presence of growth in the bladder is verified and its situation and local extensions noted. The local or general spread of the disease does not deter us in any way from carrying out the operation, if the general condition of the patient and the renal function are satisfactory. Indeed, the relief of vesical pain and frequency of micturition following the operation is very remarkable.

3. A moderately high Trendelenburg position is given and large gauze packs are introduced to keep the small intestines out of the way. An incision is now made in the posterior parietal peritoneum over the site of the ureter below the pelvic brim as it crosses the internal iliac artery. The ureter is isolated for a distance of  $2\frac{1}{2}$  inches, taking great care of the blood vessels. When so exposed, it may show vermiculation, and a certain amount of dilatation, not infrequently.

It is divided  $\frac{1}{2}$  inch proximal to the bladder and the vesical end is ligatured and carbolised. The proximal side is held aside by a long strand of catgut.

A two inch incision is now made obliquely in the bowel down to the submucosa and the mucous membrane in the lowest part of the intestinal wound is opened. The end of the ureter is brought through this and anchored half an inch below in the way suggested by Stiles. Mayo's catgut guide is not generally used now. The rest of the ureter is laid in the oblique submucous bed which is closed over it in two layers of interrupted sutures, the first bringing the muscular coats together and the second being in the Lembert style. Some of these are left long to anchor the bowel to the posterior abdominal wall. The incision over the course of the ureter is closed, so as to render it extraperitoneal to the point of anastomosis.

Dusting of the wound with sulphonamide powder and insertion of a drain in the neighbourhood are entirely unnecessary.

Closure of the parietes is carried out with great care. The risk of bursting of the wound is a real one.

At the conclusion of the operation, a self-retaining catheter is introduced in the rectum and held in position by stitches through the perianal skin for 24-36 hours.

*Postoperative care:* General care of the patient should be on the lines as after any laparotomy. Deaths from pneumonia, pulmonary embolism, acute dilatation of the stomach and paralytic ileus have all been reported and met with by me. I must record one death caused by pneumonia, superimposed upon clinically unrecognised metastases in the lungs. Another patient who seemed to be getting on satisfactorily died on the fifth day of massive pulmonary embolism confirmed at autopsy.

It is most important to see that the urinary output is steadily kept up. To the patients and nursing staff are explained how important adequate fluid intake is in the management of such cases and with their cooperation, the postoperative phase becomes smooth. As a rule, diuresis gets established in twelve hours and this being involuntary at first results in leakage by the side of the tube and bed-wetting. A rubber bedpan is very helpful to these cases. The output steadily rises to 75-80 ozs. per day in the next two or three days. The success of the whole affair depends on team-work. If the renal function is not satisfactory after twelve hours in spite of all the care, an intravenous drip is set up at once and an administration of five pints of fluid every twentyfour hours is carried on. We avoided chloride retention and resulting tissue and specially pulmonary oedema by alternating one pint of normal saline with four of 5% glucose in distilled water. This could be carried on for as long as a week. Although a digression, I would like to state that the most striking results

of such a prolonged administration, were seen in an unconscious patient with uraemia caused by prostatic hyperplasia. The intravenous fluid therapy should be combined with the subcutaneous injection of 1/200 grain of digitalin. The effect of this on the renal tubules appears to be specific—almost a potentiation in the pharmacological sense of the word. Some urologists put their patients straightaway on sodium sulphate drip at the conclusion of the operation. In such a series of 13 cases, Morson and Graham reported a mortality of 5 cases, i.e. 39%. This and the demonstration of occasional deaths resulting from the prolonged use of this drug indicate its place in the selected few cases where other and more physiological methods have failed and we used it only in a few cases.

When the rectal tube is removed, the patient gradually develops control over this new mode of micturition and in about six weeks, he has a fairly good control.

I cannot recall a single case of peritonitis (in a series of twenty cases on which this paper is based) after this operation. Abdominal pain, localised tenderness, rigidity and pulse charts are carefully watched from this point of view.

#### *Follow-up of the cases*

The immediate results of ureter transplantation are encouraging, even in cases where radical cystectomy is not contemplated. The striking improvement of pain and frequency restore the patient to a state of normality, at least for a few months. One of our youngish patients (aged 45) contemplated marriage after discharge. Unhappily radical operation was out of the question in his case owing to local extension of the disease and involvement of the superficial glands in the right groin.

These patients get used to the rectal micturition every 2-3-4 hours, the interval varying in each case within these limits generally. The pelvic colon appears to be the new reservoir, for it is here that the urine is seen accumulated after intravenous

pyelographies. Frequency, incontinence, recurrent attacks of mild pyelitis, pain due to hydronephroses and urinary calculi are some of the clinical features in the after histories of these cases and one or the other of these may be the source of further annoyance.

The mortality following the operation varies considerably, the average being 30-35%. Priestley and Strom in an excellent series of 51 cases reported a mortality of 15.7%.

To surgeons interested in ending the sad story of malignant disease, Shakespeare's immortal words through Hamlet should be a constant inspiration.

To be or not to be, that is the question :  
Whether 'tis nobler in the mind 'to  
suffer .

The slings and arrows 'of outragéous  
Fortune,

Or to take up arms against a sea of  
troubles,

And by opposing, end them ?

# BACTERIAL FLORA OF EAR PUS IN SOUTH INDIANS

by R. ANANTHANARAYANAN.

The suppurating ear has been a problem in the army. It has been a cause of considerable decategorisation and invaliding. This malady is no less common in civil life. In the Govt. Stanley Hospital, E. N. T. Department, out of 1412 new cases in December 1947, 451 were cases suffering from suppurating ear i.e. 31.94%. In this paper an attempt is made to study the bacterial flora of ear pus. The material was taken from the patients attending the E. N. T. Out-patients' Dept. of the Stanley Hospital.

The study was done in three parts. (1) The bacterial flora of the normal ear (external ear) of 60 hospital class of people were studied. The specimens were taken from the donors who attended the Stanley Hospital Blood Bank. A sterile swab dipped in sterile glucose broth was used to swab out the ears of such of those who gave no history of ear troubles. An auroscopy was done in each ear to make certain that it was not a pathological ear. In each case a direct smear and cultures on glucose broth, serum agar, Douglas agar, inspissated serum and D.E.C. medium were studied. In the first fifteen cases, cultures on glucose agar tubes were put up for fungi. No fungi were grown. The following table gives the flora met with:—

Name of Organism	Percentage
1. Staphylococcus Albus ..	91.60 %
2. " Aureus ..	3.33 %
3. " Citreus ..	13.33 %
4. Chromogenic Cocci (Brick Red & Red) ..	5.00 %
5. Gaffkya Tetragena ..	6.00 %
6. Diphtheroids ..	30.00 %
7. Spore bearers Aerobic ..	70.00 %
8. B. Pyocyaneus ..	1.67 %
9. Yeast Cells ..	18.33 %
10. Vincents Spirochaetes ..	1.67 %
11. Fusiform Bacilli ..	1.67 %
12. Enterococci ..	1.67 %

The author is indebted to Drs. P. S. Natesan, T. Nandagopal and Sundararajan of Stanley College and Hospital for advice and help.

(2) The bacterial flora of the normal oropharynx was studied in twenty cases. Swabs were taken from normal oropharynx by Dr. T. Nandagopal, Hon. Asst. Surgeon, E. N. T. Department, Stanley Hospital and sent to me. The flora were as given below:—

Name of Organism	Percentage
1. Staphylococcus Albus ..	85.00 %
2. Gaffkya Tetragena ..	5.00 %
3. Streptococcus Non-Haemolyticus ..	100.00 %
4. Pneumococci ..	20.00 %
5. Diphtheroids ..	60.00 %
6. Vincents Spirochaetes ..	5.00 %
7. Organisms morphologically resembling C. Diphtheriae ..	5.00 %

(3) Swabs of pus from 100 ears were sent by the E. N. T. Department for this investigation. A direct smear and cultures on Douglas agar, serum agar, glucose broth, blood smeared agar, inspissated serum, Tellurite medium and D.E.C. medium were studied.

Name of Organism	Percentage
1. Staphylococcus Aureus ..	71.00 %
2. " Albus ..	5.00 %
3. Gaffkya Tetragena ..	3.00 %
4. Streptococci ..	39.00 %
5. Diphtheroids ..	66.00 %
6. Organisms morphologically resembling C. Diphtheriae ..	21.00 %
7. Vincents Spirochaetes ..	26.00 %
8. Fusiform Bacilli ..	28.00 %
9. B. Pyocyaneus ..	34.00 %
10. B. Coli ..	7.00 %
11. B. Proteus ..	18.00 %
12. B. Asiaticus ..	2.00 %
13. B. Morgan ..	1.00 %
14. B. Lactis Aerogenes ..	1.00 %
15. M. Tuberculosis ..	1.00 %
16. Yeast Cells ..	2.00 %
17. Spore bearers (Aerobic) ..	14.00 %

This study was stimulated by the varied flora of ear pus which I came across

on routine investigation. The class of people from whom swabs were taken in Part(1) forms more or less a cross section of society: doctors, technicians, laboratory workers, labourers, carpenters, drivers, ward-boys, mechanics, bakers, ryots, painters, etc. The normal flora of the external ear, and oropharynx — as an alternative to the normal Eustachian tube—were studied as they form the gateways to the middle ear.

The investigations showed that (i) Vincent's infection of the ear is much more common than believed, viz. 26%. (ii) Organisms resembling *C. Diphtheria* morphologically are fairly common, viz. 21%. (iii) *B. Pyocyaneus* is of frequent occurrence, viz. 34%. The large percentage of aerobic spore bearers is worth noting. Vincent's infection was characterised by the tendency to bleed readily, on even gentle manipulation of the infected area (Nandagopal). *Diphtheria* was never suspected but was found during routine investigation. The patient had no obvious ill effects due to this in the ear or elsewhere. A few of the strains of *C. Diphtheria* were tested for toxicity and were found to be of the *mitis*

variety. *B. Pyocyaneus* was the cause of considerable discomfort and was intractable to treatment. In the case of the ear from which *M. Tuberculosis* was seen in smears and grown in cultures, the patient had Tuberculosis of the Lungs for which he had been treated. The presence of *B. Proteus*, *B. Coli*, etc. is probably due to unclean personal habits. All the strains of *Staphylococcus Aureus* isolated—except where they were occurring in conjunction with *B. Pyocyaneus*—were tested for coagulase and haemolytic power. They were positive for both. No study was done on the haemolytic power of *Streptococci*.

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## CASES & COMMENTS

### MULTIPLE MYELOMA — A CASE REPORT\*

by C. RAGHAVACHARI.

Cases of multiple myelomata are rare, and further the case reported here shows several unusual features worthy of recording. The features of a typical case of multiple myeloma were understood to be—incidence in later age periods, multiple lesions in flat bones, tendency to pathological fracture, radiological features of punched out areas, urine changes and ultimate fatal end. There are a number of features in which the case under report differs from the typical. Recent reviews of series of proved cases of multiple myeloma have brought out the typical and some of the atypical features of this disease. *Chormley and Pollock*<sup>1</sup> have reviewed a series of 86 cases detected during 1924—36 at the Mayo Clinic stressing the features of the disease and calling particular attention to the diagnostic difficulties in early cases. There is another review of 83 cases by *Bayrd and Heck*<sup>2</sup> who also stress the varied clinical and laboratory features of this disease. The case under report was under observation for 8½ years making it possible for a detailed study and follow up of the case.

#### CASE REPORT

The patient Kandaswamy, Hindu, male, 17 years, was admitted on 27-9-1938 for multiple unsightly protuberances on the forehead, face, chest, etc., of six months' duration.

Personal history: There was no history of syphilis or of trauma.

History of onset: The patient noticed lumps appearing in his forehead, face, etc., after taking some indigenous medicine for stiff joints 6 months previously. The onset was afebrile. They appeared in the following order:—Right forehead, left side of forehead, above the eye brows, over the face and then over collar bones.

Condition on admission: General condition fair; not anaemic; afebrile. Facies resembled that of

leontiasis ossea (Fig. 1). There was no exophthalmos; there was no swelling in the neck. Abdomen: showed no appreciable disease. Genitals were normal. There was no lymph-adenopathy.

Local condition: There were twenty lumps distributed over the following regions:—

*Head*: Right & left frontal regions, right frontoparietal region, right & left supraorbital margin and left maxilla.

*Trunk*: Middle of right & left clavicle; manubrium and body of sternum and ninth rib.

*Extremities*: Lower ends of right & left humerus, lower third of right ulna, right & left metatarsal base, over the tibial tubercle, over the prominence of the left heel and bases of the first and second metatarsal.

The lumps varied in size from nodules of ¾" diameter to elongated masses 2" and ½" broad. They were of different degrees of hardness, all fixed to bone, some tender but none warm to touch. Skin was freely movable over swellings. There were no prominent veins. Those over flat bones were rounded, while those over the ends of long bones were fusiform.

Examination per rectum: no appreciable disease.

#### INVESTIGATIONS

##### I. Urine:

No albumin. No sugar. No Bence Jones protein. Deposit: Nil. Output normal. Intravenous pyelography: nil abnormal.

##### II. Blood:

R.B.C. 4.5 million/c.m.m. Hb. 75% (Zeiss).  
W.B.C. 10,000/c.m.m. P-45% L-15% M-2% E-39%  
Kahn Reaction—Negative.  
Blood Sugar (fasting)—100 mgm %  
Blood urea—30 mgm %  
Serum Calcium—10 mgm %  
Serum Phosphorus—3 mgm %  
Plasma Cholesterol—180 mgm %

##### III. Skiagraphic Findings:

*Skull*: Punched out areas of rarefaction. A large irregular area of rarefaction with well defined margins. Geographical design of skull. Fluffiness of external table over parietal region. Periosteum appears lifted. Upper and lower jaws show areas of bone destruction. Figs. 3 and 4.

\*From the Department of Surgery, Stanley Medical College. The author is grateful to the late Dr. Bhaskara Menon, to the late Dr. Sundaresh and to Dr. Natarajan for valuable help rendered.



Fig. 1.

Clinical Photo October 1938 A.P. view showing lesions in forehead.



Fig. 2.

Clinical Photo. October 1938 Lateral view showing lesions in forehead.

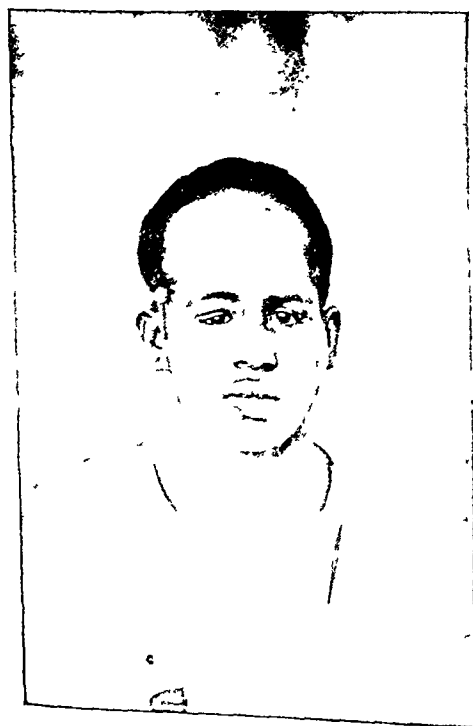


Fig. 1-a.

Clinical Photo. A.P. view showing regression of the forehead lesions after deep X-Ray therapy.



Fig. 2-a.

Clinical Photo. Lateral view showing regression of the forehead lesions after deep X-Ray therapy.



Fig. 3.  
A.P. view of skull showing lesions.



Fig. 4.  
Lateral view of skull showing punched out areas  
and a 'geographical design' in one area.



Fig. 3-a.  
A P view of skull after the course of deep  
X-Ray showing complete bone reformation.



Fig. 4-a.  
Lateral view of skull after the course of deep  
X-Ray showing complete bone reformation.





Fig. 5.

X-Ray of chest showing the ghost-like appearance of sternum.



Fig. 5-a.

X-Ray of chest showing complete reformation of sternum after deep X-Ray therapy.

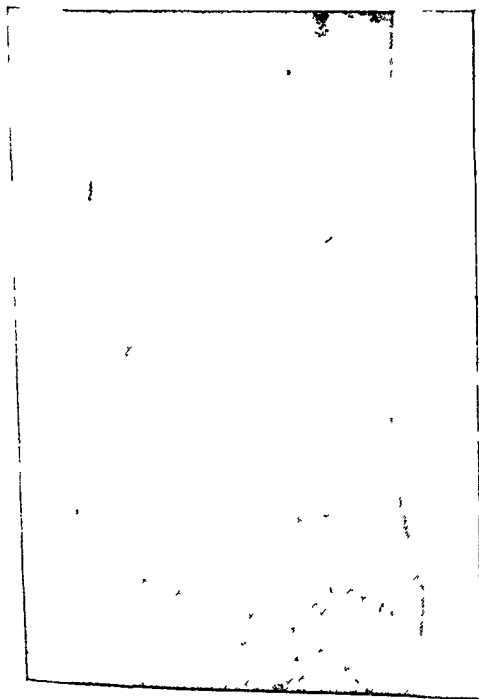


Fig. 6.

X-Ray of forearm showing a typical rarefied area near the end of ulna.

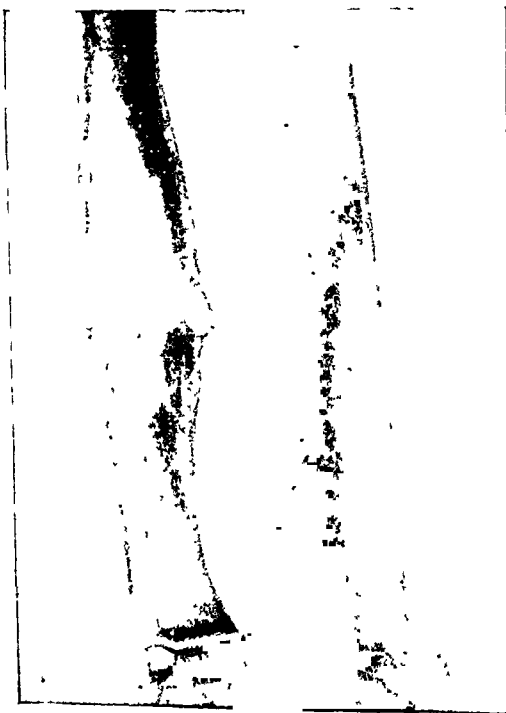


Fig. 6-a.

X-Ray of forearm showing the same lesion after deep X-Ray.



Fig. 7.

Lesion in tibia—showing sub-periosteal new formation. Note that appearance is like that of osteogenic sarcoma.



Fig. 7-a.

Same lesion as above showing consolidation after deep X-Ray.

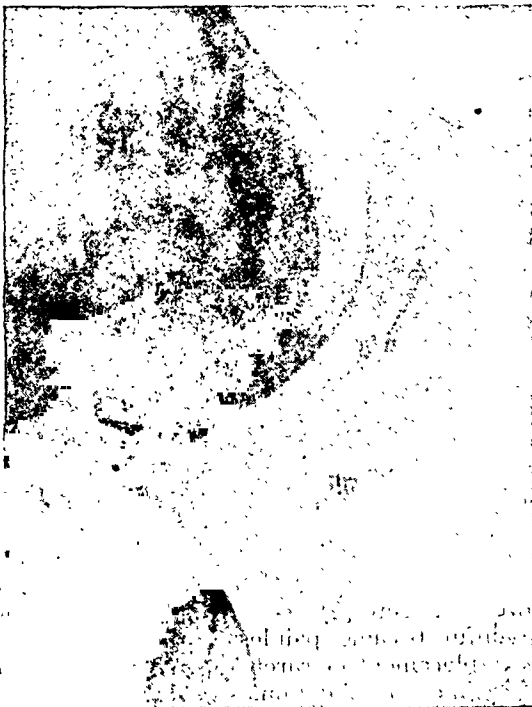


Fig. 8.

X-Ray of right patella showing a fresh lesion.



Fig. 8-a.

X-Ray of right patella after the course of deep X-Ray.

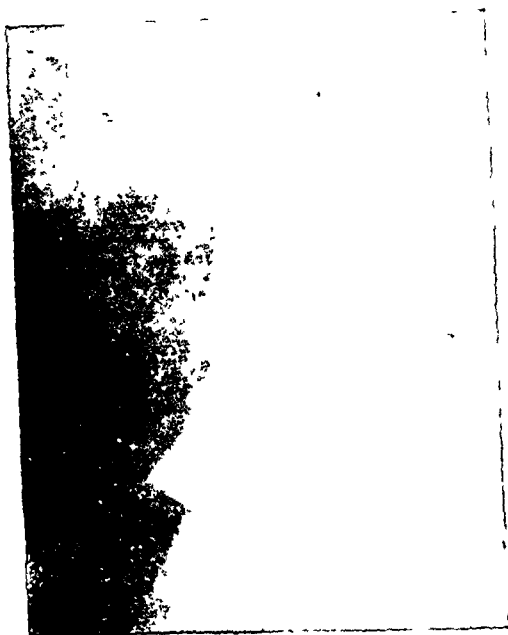


Fig. 9.

X-Ray of right patella showing a recurrence some time after deep X-Ray exposure. Note the appearance is like that of osteoclastoma.

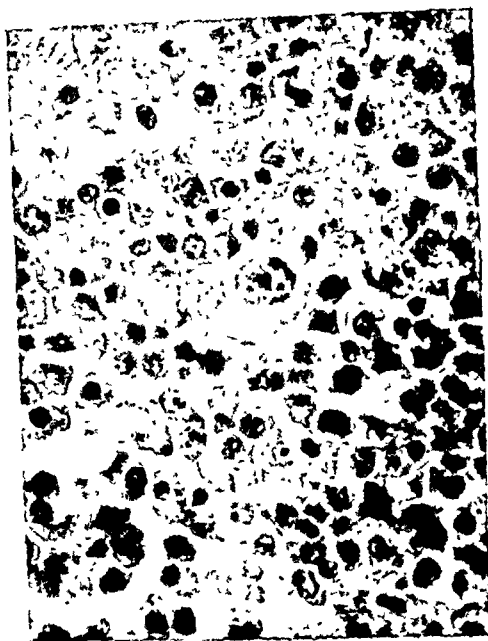


Fig. 10.

Microphotograph—biopsy of excised right patella—multiple myeloma of plasmocytoma type—shows a giant plasma cell and other plasma cells with condensed dark staining nuclei and also cells with more open cartwheel nuclei.

Trunk: Moth eaten appearance of the affected areas of clavicle and rib. Sternum presented a ghostlike appearance. Fig. 5.

Long Bones: Sites of affection near the ends. Elongated areas of bone rarefaction; slight expansion of shaft. The spine, pelvis and femora were free. Fig. 6.

#### IV. Biopsy:

Two specimens—one from the swelling from the skull and another from the swelling from the ulna. Report:—No evidence of lipoidladen-cells or myelomatous infiltration; but thinned out poorly calcified trabeculae and wide Haversian canals occupied by chronic inflammatory fibrous tissue. Re-examination revealed opened up trabeculae occupied by proliferated fusiform cells in columns—fibroblasts.

#### TREATMENT

A course of deep X-Ray therapy was instituted. The swellings retrogressed in size and such as were painful became painless. Later skiagrams showed replacement of rarefied areas by new bone formation and consolidation. The reformation of sternum is particularly noteworthy. The complete reformation shows response to deep X-Ray therapy. Fig. 1-a, 2-a, 3-a, 4-a, 5-a, 6-a.

Patient was re-admitted in August 1911 for a tibia. X-Ray picture

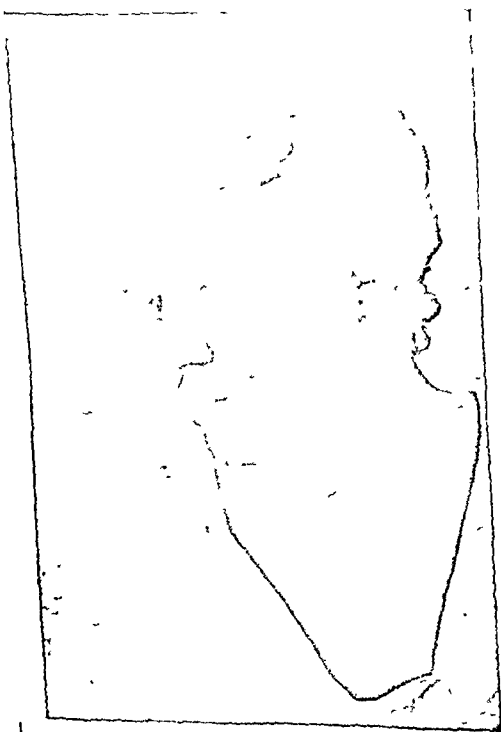


Fig. 11.

Clinical Photo—January 1945. Showing lesion in temporal bone.

was very much like that of osteosarcoma. Deep X-Ray therapy was given. Tumour subsided and patient was discharged. Fig. 7 and 7-a.

On 8th November 1942, patient was again admitted with irregular fever and a tumour in the right patella. Biopsy was done; with no fresh information. Deep X-Ray therapy was given. X-Rays: Figs. 8 and 8-a. Patient was discharged on 8-2-1943.

On 31-4-43 patient was admitted again for recurrence of the tumour in the right patella. X-Rays: Note that X-Ray shows a radiological picture which resembles that of Osteoclastoma. Fig. 9.

Operation: Excision of patella was done more with a view to get material for Biopsy. Post-operative: Wound healed by first intention. Full range of knee movement returned. Patella was sent for pathological examination.

Report: Multiple Myelomatous lesion plasmocytoma type—Tumour showing a giant plasma cell and other plasma cells with condensed dark staining nuclei and also cells with more open cartwheel nuclei. Fig. 10.

Treatment: Deep X-Ray therapy was given, postoperatively to the region.

On 19-6-1944 patient was admitted at night time complaining of severe headache, vomiting, giddiness of one month's duration and facial asymmetry on left side and loss of taste of 2 week's duration—a typical picture of intracranial encroachment. He had an irregular swelling  $2\frac{1}{2}'' \times 1''$  in the left temporal region above the ear. It was soft, fluctuant, tender and not movable over bone. He had an infra-nuclear type of facial nerve paralysis on the left side with loss of taste in the anterior two-thirds of the left side of the tongue. Fig. 11.

Fundus examination and lumbar puncture showed evidence of increased intracranial pressure. A course of deep X-Ray had marvellous effect on the local lesion and the general condition and the patient was discharged on 2-2-'45 with a residual facial nerve palsy.

Patient was readmitted for the last time on 29-5-46 complaining of epistaxis and pain over left maxillary region. Ear, Nose, Throat report:—Left antrum opaque. Polypus arising from fronto ethmoidal region. Biopsy was taken. Biopsy report: Myeloma of plasma cell type.

Fundus examination: Secondary optic atrophy left; no perception of light. Urine showed Bence Jones Protein on 1-6-46. Serum Protein 7.0 Gm. R.B.C. — 3.2 mill. Hb. 70%. Patient had a course of deep X-Ray which was finished on 9-8-46. He was discharged a few days later in a bad state against medical advice and presumably died soon after.

## DISCUSSION

The case under report presents quite a number of unusual features associated with the disease. Though the patient was under observation and treatment from September 1938, the correct diagnosis was arrived at only in 1943. The negative laboratory findings, absence of Bence Jones proteinuria and the biopsy report, prevented us from correctly diagnosing the condition though it was suspected to be one of multiple myeloma from the beginning. The unusual features of the case are (a) The young age of the patient, 17 years; (b) the very long survival period ( $8\frac{1}{2}$  years), (c) the absence of lesions in the vertebra and pelvis and (d) the site of lesions in the ends of long bones, (e) the absence renal dysfunction and (f) the absence of Bences Jones proteinuria till just before the very end. There was no pathological fracture in any of the lesions. In retrospect one is inclined to blame the first biopsy—that the specimen was not taken properly. The earlier negative biopsy report is explained by "the possibility that the biopsy tapped only the periphery of the lesion. The widening of Haversian canals which are filled by fibroblasts mentioned in the first biopsy report refers to the connective tissue reaction found around any infiltrative growth." (Dr. T. Bhaskara Menon.)

At first a diagnosis of osteitis fibrosa multiplexa was made. However the patient had the benefit of deep X-Ray exposures—started on an intuitive empiricism under the direction of late Col. Mahadevan whose case it was. But for this the case might not have survived for  $8\frac{1}{2}$  years. Nor could we have come to a correct conclusion regarding the nature of the case.

Among the 86 cases reviewed by Chormley and Pollock, the average age of the male patient was 52 years whereas all the 53 clinically, radiologically proved cases were above 50 years. The duration of the disease from the onset of symptoms to death on the average was 26.9 months, though there was one case living for 10 years. The patient under review was 17 years only and

lived for 8½ years after the onset of symptoms. Another clinical feature that is peculiar to the case is the distribution of the lesions. There was complete absence of lesions in the vertebra and pelvis. In the Mayo Clinic series referred to above, the involvement of pelvis was 100% in one group and 72% in another group. Long bone involvement was not a common occurrence in the series. In this case, the majority of the lesions were in the long bones including the short long bones of the hands and feet.

Though renal dysfunction and Bence Jones proteinuria have been recorded in 73% and 64% respectively, this case showed no renal dysfunction. Urine test for B. J. protein was consistently negative throughout the 8½ years of the disease. A positive B. J. protein reaction was obtained a few weeks before death. One feature which has not been reported before is the subperiosteal new bone formation seen in the lesion in the tibia. The effect of deep X-Ray was remarkable as will be seen from the X-Ray pictures before and after treatment showing skull, sternum, tibia and patella. At the time of his last but one admission into hospital he came in a very bad state with symptoms of intracranial tumour. The improvement in symptoms was marked after deep X-Ray exposure. As noted by *Chormley and Pollock* the individual lesions showed remarkable regression after deep X-Ray exposure but the irradiation could not prevent the appearance of fresh lesions nor alter the fatal prognosis of the disease.

He went downhill soon afterwards and died.

### SUMMARY

A case of multiple myeloma occurring at the unusually early age of 17 years is described. A follow up of 8½ years was possible in this case and showed certain very interesting features that are detailed. The early onset, the long survival, absence of lesions in vertebra and pelvis so characteristic of multiple myeloma and the absence of pathological fractures are among the unusual features of the case. The peculiar type of lesion in the Tibia showing subperiosteal new bone formation giving an X-ray appearance of *osteogenic sarcoma* is noted. The remarkable response to deep X-Ray and the fact that the ultimate course of the disease is not affected by the response of the lesion to deep X-Ray are recorded. It is unusual for one in our country to have a chance of follow up in a case for a period of 8 years which I had in this case.

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## TUMOURS OF THE THYMUS

by B. RAMAMURTHI.

Tumours of the thymus are rarely found at postmortem examination and even more rarely noted in the course of clinical examination. Homburger reported the occurrence of 42 instances of enlargement of the thymus in 6,000 autopsies at the Yale Department of Pathology. Of these, five only were true tumours. In 17,000 autopsies at the Bellevue Hospital Symmers found 24 thymic tumours. The Lahey Clinic records six cases of thymic tumours in the course of 300,000 clinical examinations. The following case is reported because of the rarity of thymosarcoma.

Tumours of the thymus can clinically be classified into three groups:—

- (1) Those discovered in cases of myasthenia gravis.
- (2) Those causing typical symptoms of anterior mediastinal tumour with obstruction to the trachea and the great vessels at the root of the neck.
- (3) Those discovered accidentally during X-Ray examination.

Removal of the thymus and tumours of the thymus has been strongly advocated by Blalock as a treatment for myasthenia gravis, though the exact relationship between thymic tumours and myasthenia gravis is not yet fully established.

In suspected cases of anterior mediastinal syndrome and also in cases in which routine radiography of chest reveals abnormal shadows in the mediastinum, the determination of the exact nature of the mass by X-Ray or by screening is not always an easy affair. Plain lateral and oblique views are of great value in such a determination as also is a bronchogram. (See Fig. 2 and 4.)

According to X-Ray findings thymic tumours may present two types of pictures.

(a) One type well defined and easily seen in all radiograms.

(b) The other type, plaque like in shape and easily overlooked. It may be adherent to the aorta or to the pericardium and hence may pulsate and may be mistaken for an enlargement of some part of the cardiovascular system. Fluoroscopy may also be defective in these cases.

Differential diagnosis from other anterior mediastinal tumours like aneurysm, substernal goitre, lymphoma and dermoid cyst is essential. It may be noted here that the presenting signs of dyspnoea, cough and haemorrhage, observed in the case under report, were observed by Decker in about half the cases of malignant thymic tumours. X-Ray evidence was found only in one-third of the cases.

### PATHOLOGY

“No group of tumours has more successfully resisted attempts at interpretation and classification than those of the thymus.”—Ewing. A useful classification will be as follows:—

(a) Hyperplasia of the thymus.

(b) Thymoma (i) benign which is encapsuled and (ii) malignant which is not encapsuled.

The presence of Hassl's corpuscles and epithelial elements is helpful but not essential to mark the thymic origin of a tumour and to distinguish it from one of lymphoid origin. Small cells known as thymocytes were seen in the case under report. (Figs. 5 and 6.)

### TREATMENT

Removal of tumours whenever possible is the best way to prevent the development of malignancy or respiratory obstruction. X-Ray therapy has been attempted but, contrary to impressions given in older literature, there is no rapid or great reduction in the size of the tumour. Surgical technique permits complete extirpation of the



Fig. 1.

Showing in an anteroposterior skiagram of the chest, the tumour above and to the left of the heart shadow.



Fig. 2.

Showing in a left oblique view with barium swallow the anterior position of the tumour above the heart shadow.

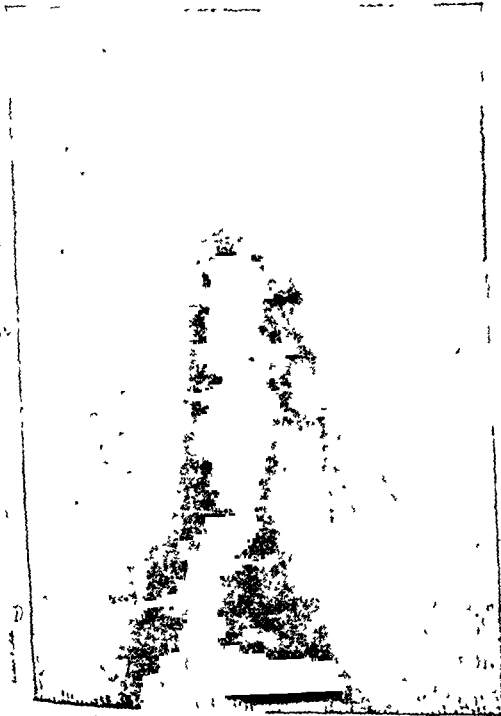


Fig. 3.

Bronchogram showing moderate bronchiectasis of left lower lobe.

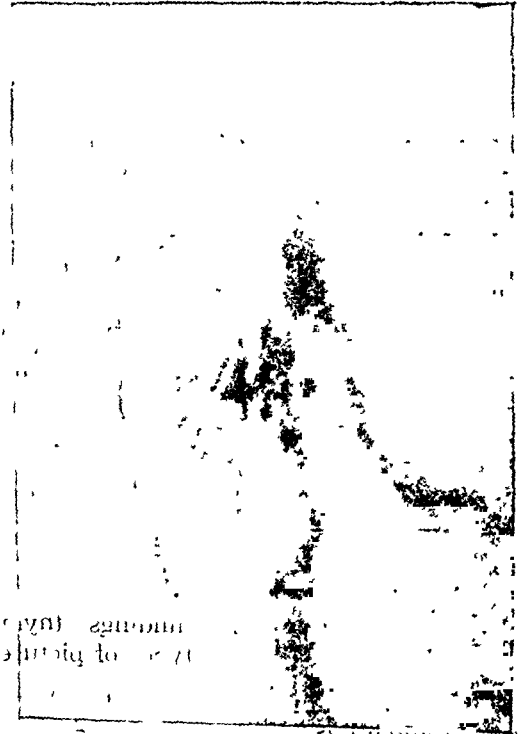


Fig. 4.

Right oblique view showing the anterior position of the tumour.



Fig. 5.

Low power photomicrograph of thymosarcoma. Note the round cells—thymocytes and the pale staining reticulum cells with irregular outline.

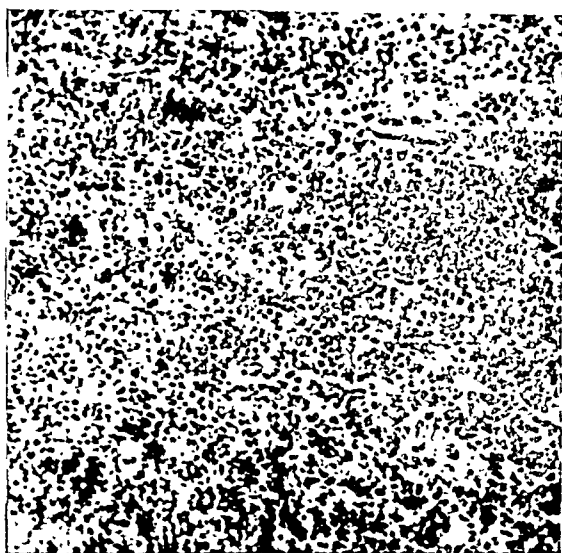


Fig. 6.

High power photomicrograph of the same.

thymus. This can be achieved by an exposure splitting the sternum or by removing one costal cartilage and dividing the others as was done in the case under report.

Discovery of a mediastinal tumour that may originate in the thymus should lead to positive action on the part of the physician. Benign tumours can be removed; malignant tumours if they cannot be removed, at least be diagnosed by biopsy and radiated.

### CASE REPORT

K, weaver, aged 30, was admitted into the medical section of the Madras General Hospital complaining of cough with blood stained expectoration since four months and pain in the left side of the chest since eight days. The cough started five years ago with fever in the evenings and since four months has been blood stained. His sleep was disturbed.

Routine examination showed dullness over the manubrium sterni and a few rales over the right base of the lung. Anteroposterior skiagram of the chest revealed a fairly regular rounded shadow projecting beyond the left border of the heart near the medial end of the third and fourth right costal cartilages (Fig. 1).

The patient was screened first without and then with barium swallow and the tumour was seen projecting a little to one side of the heart shadow and not pulsating thus excluding any cardiac swelling. On slow rotation of the patient under the screen it was made out that the tumour was in front of the heart shadow (Fig. 2).

A diagnosis of a tumour in the anterior mediastinum was made, but to make clear the correlation between the tumour and the bloodstained expectoration, a bronchogram (Figs. 3 and 4) was taken to exclude bronchogenic tumour of the lung. It showed only mild bronchiectasis of the right base of the lung. The bronchiectasis explained the cough and the presence of numerous cocci in the sputum. There were no acid fast bacilli in the sputum.

The nature of the anterior mediastinal tumour had to be decided upon. It was too low down for a substernal goitre and did not move with deglutition under the screen. There was no evidence for Hodgkin's disease. It was thought, therefore, that the tumour was either in connection with the thymus or a dermoid cyst. The patient did not reveal any symptoms or signs of myasthenia gravis with which a thymic tumour may sometimes be associated.

The patient was operated upon under intratracheal anaesthesia by Dr. N. S. Narasimhan. As the tumour was rather low down and to the left, the easier method of resection of the third costal



cartilage to expose the tumour was chosen. The pleura got accidentally opened while peeling it off the tumour. The tumour was oval in shape with the long axis in the vertical plane, irregular and lobulated. It was encapsuled and was found below the arch of the aorta and in front of the left auricle not attached to the pericardium. It could be easily removed. After putting in penicillin the wound was closed. The patient received a blood transfusion of 400 c.c. after the operation. The pathological report of the tumour was Thymosarcoma (Figs. 5 and 6).

There was an effusion in the pleural cavity which was aspirated on the 5th day and penicillin put in. The post-operative course was otherwise smooth. The effusion collected again and was aspirated. It was blood stained. The sediment of this effusion showed malignant cells. The complication of pleurisy with malignant effusion, seen in this case has been noted by Crosby.

The patient was, therefore, given post-operative deep X-Ray therapy which stopped the collection

of pleural fluid. He was discharged in good health to report after six months.

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## EXTREME TYPE OF BILATERAL GENU-VALGUM

by T. SESHACHALAM.

Instances of extreme type of bilateral genu-valgum as the one reported here must be rare as the disability and discomfort would bring the patient earlier under treatment. During a period of thirty years of surgical practice in a premier teaching hospital, I have not dealt with one of this extreme type.

wards on the tibia and the feet separated and everted, the ligaments on the medial aspects of the knees and ankles bear the strain. That this deformity is common in childhood and rare in adult life as found in

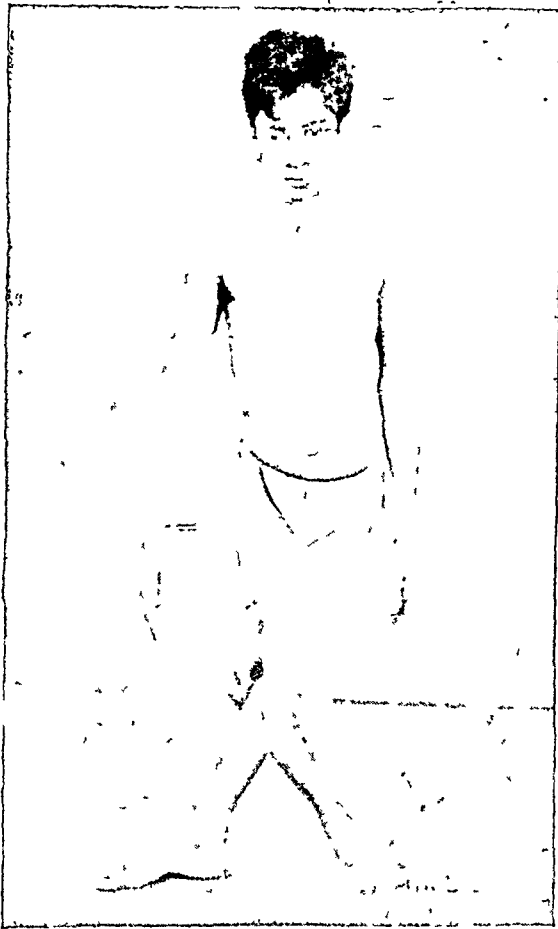


Fig. 1.

Genu-valgum is an exaggeration of the normal attitude of rest in man in which the entire weight of the body is thrown on the ligaments of the three big joints of the lower extremity. The femora being rotated in-



Fig. 2.

hospital statistics is probably erroneous as adults who become accustomed to such deformities of moderate nature do not apply for treatment unless the deformity is so extreme as to disable them.

Mild degrees of knock knee associated with valgus of ankles are corrected by manipulation frequently performed to correct the deformity supplemented by modification of shoes by raising inside of sole and heel by half an inch wedge. If after three months there is no improvement noticed, treatment on expectant lines by forcible correction followed by plaster casts is done. Knock knee in children under 5 years of age do very well under this treatment as the rectifying force of nature lends great help. The necessity for operation implies neglect on the part of the parents or failure of expectant treatment. Supra-condylar osteotomy of the femur to change the inversion and rotation of the femur is the operation of choice.

#### CASE REPORT

Boy aged 18 years, an attender in a hotel has been carrying on his avocation with bilateral genu-valgum, which has been gradually increasing since his childhood resulting in this extreme type (Fig 1). The gait of the patient has been awkward, his progression slow and the interference of the knees with each other was gradually getting worse. So he sought treatment. The ankles have developed a compensatory varus con-

dition to help progression. Macewen's osteotomy was performed on both sides, deformity was corrected and both limbs were enclosed in a plaster spica extending from the pelvis and enclosing the inverted feet. The original cast was removed in 8 weeks and a second cast excluding the hips was put on allowing the patient to move about on crutches. Perfect mechanical benefit has resulted from the operation (Fig. 2) and when last seen six months after his discharge from hospital the correction has not only been maintained but the formerly dejected boy has now assumed a self confident mood.

#### SUMMARY

A case of extreme type of bilateral genu-valgum with scissor like deformity is reported. The excellent result of Macewen's osteotomy even in this extreme condition is demonstrated.

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#### REVIEWS OF BOOKS

**Buchanan's Manual of Anatomy**, 7th Edition, Edited by F. Wood Jones, Bailliere Tindall and Cox, London, 1946. Pp. 1616, viii.

This is the latest edition of a well tried book. For nearly forty years it has served as a convenient text-book of Anatomy for the senior undergraduate and the post-graduate student, used by him for revising the subject on a topographical or regional basis in the dissection room or Anatomy museum. The paper, typography and binding are better than in previous editions.

The 'magic' touch of the new editor, Prof. Wood Jones, is clearly seen. Much new matter has been added, along with some fine line-drawings from the editor's own artistic pen. The skiagrams are a necessary and welcome addition, and most of them are really excellent. The glossary has always been a feature of Buchanan's Anatomy. It is all the more useful now when modern students of medicine are not required to have a prior acquaintance of Latin and Greek. The short biographical notes on famous Anatomists of the past are stimulative in developing the historical

perspective in the student. This book is highly recommended for the senior student of Anatomy.

A. A. A.

**The Treatment of Malignant Disease by Radium and X-Rays** being a practice of Radiotherapy by Ralston Paterson, M.C., M.D., F.R.C.S.E., D.M.R.E., F.F.R., Shristie Hospital and Holt Radium Institute, Manchester. Published by Edward Arnold & Co., London—1948.

This is the third of a series of publications from Holt Radium Institute, Manchester in recent months. The two previous ones, "Second Statistical Report of the Holt Radium Institute" and "Radium Dosage—The Manchester System" have been received well and read with interest by all English speaking Radiologists. This third one is an important treatise on Radiotherapy, which has been a long felt need.

Radiotherapy though comparatively a very young speciality in Medicine has made remarkable progress in recent times. Ideas about the principles and practice of Radiotherapy have as a result of this rapid evolution been changing from year to year and worker to worker. Several well known pioneer workers in this field have published their experiences in journals and books but the graduate student and the specialist had all along found a lack of definiteness in their statements of technique. Dr. Paterson's work has come none too soon to fill this gap worthily.

This book, as the author claims, is "neither a complete text book nor an attempt to sum up the present state of radiotherapy". It is largely a description of the work done at Holt Radium Institute, Manchester the aim being "a reasonable

synthesis of most that is well tried out" and in this the author has done admirably well steering clear of all controversy and dogma, and placing before the student and the specialist a clear and lucid approach to the practice of Radiotherapy as it stands today.

Beginning with the basic principles of Radiation Therapy, the author deals with exceptional clarity with the details of the technique of X-Rays and Radium Therapy. The Manchester System of Radium dosage is briefly yet thoroughly dealt with and valuable dosage data given and graphs appended. A chapter is devoted to planning and prescription of X-Ray treatment. The chapters on Beam direction and the construction of Radium moulds worthily fill a much needed want and will be read with profit by Radio-Therapists and Physicists alike. There is a chapter on Radiobiology by Edith Paterson, wherein the current views on biological principles of Radio-Therapy have been well summed up. This and the last chapter "New Therapeutic Agents" dealing with Neutron Irradiation and Radio Active Isotopes will be of great value to the student and practitioner. A chapter is also devoted to the organisation of Radiotherapy Departments which the administrator will find very useful.

With all these features the book is bound to be an unqualified success. It is nicely got up with many valuable illustrations. It is indeed a very valuable work which should find a place on the shelf of every Radio-Therapist and practising surgeon, who is interested in the treatment of malignant disease. The greater the number of surgeons that read this book the more will be their contribution to the rational and correct treatment of malignant disease.

K. M. R.

